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Practical and Theoretical Mechanics and Chemistry.

On Hydraulic and Common Mortars. By General TREUSSART, *Inspecteur du Genie. Translated from the French by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

(CONTINUED FROM VOL. XX, P. 399.)

ART. VII. *Of Artificial Trass and Puzzalona.*

Mr. Baggé, a Swedish Engineer, was, I think, the first who attempted to make artificial puzzalona. This Engineer used, in his experiments, a species of black, and quite hard, schistus; he heated it highly several times; afterwards reduced it to powder, and having mixed it with lime, announced having obtained an excellent mortar, having all the properties of mortar made of puzzalona.

I do not at all doubt the success of Mr. Baggé: but his experiments having been repeated elsewhere, a less satisfactory result was secured. This was owing to using schists of a different composition, and which, in lieu of being heated highly, like those of the Swedish Engineer, required to be heated moderately.

Mr. Faujas de Saint-Fond made several researches in 1778 with the puzzalonas of Vivarais, which he found to be equal to the puzzalonas of Italy. He showed, also, that the trass of Andernach was a true puzzalona.

In 1786 Mr. Chaptal repeated the experiments of Mr. Faujas de Saint-

Fond, on the puzzalonas of Vivarais, and found that they were inferior to those of Italy. This contradiction between the results obtained by Mr. Faujas de Saint-Fond and Mr. Chaptal is easily explained, for one used hydraulic lime in his experiments, and the other used fat lime.

Mr. Chaptal published in 1787 a memoir on the use of the ochreous earths of the south of France. These earths were calcined in a kiln like those used in some countries for burning lime. The kilns are reversed cones from about eight feet eight inches to about ten feet ten inches in height, and are from six to eight feet in diameter at the base: an opening is left near the apex of the cone, through which to withdraw the products of calcination: these kilns are filled by placing alternately, a layer of sea-coal or turf, and a layer of the ochreous earth; the fire is kindled, after a few layers have been placed, and, when it is in full action, other alternate layers are added until the kiln is full. When the lower portion, which was the first heated, is sufficiently calcined, it is withdrawn as fast as necessary, and other new layers of clay and fuel are successively added above. Thus the burning is continual; the clays heat gently near the top of the kiln, and are subject to a much greater heat in the middle: they gradually cool towards the bottom, by the action of the current of air, after the fuel is consumed. This manner of burning earths, possesses great advantages as I shall have occasion to show. It would be equally advantageous to calcine hydraulic limes in these kilns, because, as we have seen above, it is very important to use these limes soon after they are burned. By constructing several kilns of this kind, there might be as great a supply of fresh lime as could be needed.

Mr. Chaptal attributed to iron, a great effect in improving puzzalonas; and he appears to have attributed a very feeble one to alumine. Mr. Vicat says, on this subject, in his memoir: "If, as Mr. Chaptal assures us, clays deprived of iron, and calcined, cannot be employed as puzzalonas, it must be the oxide of iron that acts principally on the silex and modifies it, by the aid of fire in the ochreous earths, as the lime does in the hydraulic limestones: the alumine, therefore, appears to take the least part in these reactions; it does, nevertheless, make part of good puzzalonas."

Experiments which follow will show that iron plays no part in the preparation of puzzalonas, while alumine is very active. We shall see, also, that there is another substance which is very active and which has occasioned the divergencies of opinion on the preparation of puzzalona; but I will not anticipate; and will go on with the statement of the various attempts made to produce factitious puzzalona.

From experiments made at Cherbourg in 1787 by Mr. de Cessart, it appeared that basalts, obtained in the Department of the *Haute-Loire*, and pulverized after having been calcined, produced a mortar possessing all the qualities of those made with Italian puzzalona. Analysis shows this basalt to contain in one hundred parts, the following; Alumine, 16.75; Silex, 44.50; Oxide of iron, 20.00; Lime, 9.50; oxide of Manganese, 2.37; Soda, 2.60; Water, 2.00; loss, 2.28.

The works in the port of Cherbourg required a great quantity of puzzalona; but the war which broke out with England on the rupture of the treaty of Amiens, raised the substance to an exorbitant price: it was calculated that the price of a cubic metre (35.54 cubic feet) cost, in 1803, more than 400 francs (about $76.00.)

They might easily have procured on the spot, clays which would have given results absolutely the same as those afforded by Italian puzzalona, at

the cost of about 30 francs (about $6.00.) And had they understood the manner of making puzzalona, there would have been a great saving. Considerations of this sort induced Mr. Gratien, Senior, Engineer of roads and bridges, to occupy himself with the subject. He made a few essays with the porcelain clay of Valognes, and made many with the schists of Haineville, which he calcined, in repetition of the experiments of the Swedish engineer. The Valognes clay calcined, gave but feeble results; the Haineville schists gave better; analysis showed this schist to consist, in 100 parts, of the following: alumine, 26.00; silex, 46.00; magnesia, 8.00; lime, 4.00; oxide of iron, 14.00; loss and water, 2.00. The results of the experiments of Mr. Gratien, Senior, are given in two memoirs which he published, one in 1805, the other 1807. A commission of the Institute was charged with examining experiments, comparative of mortars made of puzzalona, of trass, and of the Cherbourg schist; the judgment of this commission is inserted by Mr. Gratien in his memoir of 1807. page 9; it declares "that after taking from the water the twelve boxes of beton of different compositions:

"1st. All had acquired a certain consistence, but very different amongst themselves.

"2nd. The difference was striking between the betons composed of puzzalona and trass, and those into which these substances did not enter.

"3rd. The two compositions of burnt and pulverized schistus offered a resistance quite satisfactory, but not so great as it probably would be after a longer immersion.

The above report shows that Mr. Gratien obtained with the schists, results inferior to those given by puzzalona.

In 1806 Mr. Le Masson, Engineer of roads and bridges, at Rouen, attempted, in concert with Mr. Vitalis, to make factitious puzzalona by calcining yellow ochreous earths, according to the process of Mr. Chaptal. The betons made with the calcined earth, having acquired a remarkable consistence, Mr. Le Masson, in 1807, repeated the experiments on a larger scale: he immersed, in the Seine, casks filled with beton made of the calcined ochreous earth. After six months, the casks were taken out, and it was found that the betons had acquired such hardness that it was necessary to strike it two hundred times with a mass of iron weighing $26\frac{4}{10}$ lbs. to break in a depth of ten to twelve inches; the tenacity was so great, that the entire mass weighing 2800 lbs. was suspended by means of a *tire fond* (lewis?) Mr. Gratien and Mr. Vitalis judged that the masonry had acquired a hardness greater than could ever be absolutely necessary, even in constructions that require the greatest solidity in their foundations. These experiments are reported in the memoir of Mr. Gratien 1807—page 46 and following.

Mr. Vicat in his memoir of 1818 confined himself to reporting the different attempts that had been made, up to that time, to form artificial puzzalona: but in 1819 he sent to the Institute a memoir on that subject. I do not know whether this memoir was printed, but an extract is contained in the *annales de chimie et de physique* of 1820, Vol. XV, page 365 and following. After several observations on limestone, on the action of fire on calcareous stones, and the combination of water with lime, the author gives a succinct history of puzzalona. We find afterward the following passage.

"Since the quality of natural hydraulic lime, depends solely on the presence of a certain quantity of clay, combined by fire with the calcareous matter, it was natural to think that by mixing clay in suitable proportions with fat lime, slaked, no matter how, and then submitting the mixture to

calcination, a similar result would be obtained: experiments made on a large scale, and in many places, have confirmed this idea in a manner so complete, that it is now possible to fabricate any where, and at a very moderate price, artificial lime superior to the natural analagous lime."

"In like manner, since chemical analysis gave, for the constituents of natural puzzalona, silex, alumine, oxide of iron, and a little lime; it was easy to suppose that our clays, of which the composition is altogether similar, might be transformed, by burning, into artificial puzzalonas. This idea was already old at the period of the experiments of the author of these researches; but by a remarkable fatality it was as if stricken with sterility: the circumstances on which the quantities of good puzzalona depend, had not been determined with sufficient precision. There was a persuasion, for example, that iron was very active therein; that, therefore, only ochreous clays should be used; that in order to a more perfect imitation of nature, there should be a high degree of heat, 'because,' said they, 'the fire of volcanos is much more intense than the fire of our kilns.' (Several geologists are of a contrary opinion.) Certain puzzalonas, came, beyond doubt, in the form of lava, from volcanos: they were in fact subject to a high degree of heat; but since the very distant epoch of their formation, they have sustained diverse decompositions, either from intestine modifications or from the action of acid vapours, or from other causes, and these decompositions have totally changed the mode of combination of their principles. As to the red puzzalonas of the neighbourhood of Rome, every thing shows that they were only vast beds of ochreous clay variously burned, either by subterranean fires, or by currents of lava which covered them and broke them up in every direction. Thus their quality is very variable according to the disposition and depth of the beds. But whatever may be the process of the formation of these substances, it is demonstrated that all the mystery of their properties, resides, not in the presence of iron or lime, but in a particular state of combination of silex and alumine—a state to which all clays, soft and greasy to the touch, may be brought, with the greatest facility, by a light calcination. The means which hitherto appear to have succeeded best, consists in reducing the dry clay to a very fine powder, and calcining it, for some minutes, on metallic plates heated to an obscure (*brun*) red. The truth is, that practice has not yet fully matured the process, and it is probable that full success requires the contrivance of a mode of calcination more expeditious and convenient than the above: but the problem is not the less resolved."

Such is the mode proposed by Mr. Vicat for making factitious puzzalona; and he teaches us nothing new, for he does not tell us what is the particular condition in which the silex and alumine should be found to afford good results. Opinions were for a long time divided on the question whether the clays, which it was desired to convert into good cements, should be heated much or little—these cements being, really, artificial puzzalonas.* Mr. Vicat has adopted the opinion of those who thought they should be burned but little; but experiments which are to follow will show that this (as a general principle) is erroneous—it being necessary to burn more or less, according to the composition of the clay. The problem, therefore, was not resolved by Mr. Vicat, though he says it was; and the experiments which follow will show in what it really consists.

* By the term *ciment*—translated, in the above sentence, *cement*, the French often mean, simply brick dust or tile dust; and it will be so rendered wherever it is supposed to bear that meaning.—Trans.

I made several essays, substituting brick and tile dust for trass. To this end I composed a number of mortars of fat lime and the dust of bricks or tiles taken from all the kilns of the neighbourhood. A part of the mortars were made of brick dust, and a part of tile dust. I obtained many results:—sometimes very good, sometimes indifferent, and sometimes very bad. What struck me much, at first, was, that mortars made of different dusts coming from the same burning gave very different results: notwithstanding that the dusts were of the same burning, were all made of the same clay, were used with the same lime, and that all other circumstances were the same. I saw from this, that great risk was run of making bad mortar, by taking brick or tile dusts without discrimination. I know that the great majority of constructors preferred highly burned dusts, and that, although made of the same clay, they much preferred dust of tiles to that of bricks. To settle my opinion on these two points, and to explain up contradictory results that I had obtained, I made the experiments reported in the following table.

Table No. XVI.

No. of the mortar	Composition of the mortar.			No. of days required to harden in water.	Weight supported before breaking.
				days.	lbs.
1	Fat Lime slaked to powder and measured in powder	1	3	11	330
	Dust of bricks but little burned	2			
2	Lime the same	1	3	+40	180
	Dust of bricks well burned	2			
3	Lime the same	1	3	5	275
	Dust of tiles but little burned	2			
4	Lime the same	1	3	+30	125 *
	Dust of tiles well burned	2			
5	Lime the same	1	3		
	Dust of tiles same as No. 3 but which had been reburned in a reverberatory furnace for six hours.	2			

Observations on the experiments of Table No. XVI.

In order to make the above five experiments, I went to the nearest brick-yard, at Strasburg; and there got bricks and tiles, both lightly burned, and well burned. It was easy to dintinguish them, for the first were very red, and but feebly sonorous, while those which were *well burned*, as it is called, were of a fawn colour (*fauve*) (pale red) and quite sonorous. The burners are never mistaken in this particular.

The first four experiments show that I obtained much better results with bricks and tiles but little burned, than with those well burned. We see, also, that the hardening was much more prompt, with the slightly burned dusts: for No. 2 required more than forty days to harden, while No. 1 required but 11 days; No. 4 took more than 30 days to indurate, while No. 3 took but 5 days. We see, also, contrary to the general opinion, that brick dust gave better results than tile dust. No. 5 was made with the

* In my pamphlet of 1824, and in the 7th number of the *mémorial*, copied therefrom, the resistance, by a typographical error, is set down as 87 kil. (194 lbs.) Au.

same dust as No. 3, after it had been reburnt for six hours in a reverberatory furnace, keeping it constantly at a low red heat. The mortar made of this last dust took no consistence, and when I withdrew it from the water after a year, it was as soft as if it had been made of lime and sand only. This shows how important it is not to use these dusts at hazard; for they are always costly and are sometimes no better than so much sand. More than one fault of this kind has been committed in great works, as I shall have occasion to remark. The experiments of the above table agree with the opinion of Mr. Vicat, who says, that clay should be submitted to a feeble heat only. But on resorting to another tile kiln, where they used another clay in making bricks and tiles; and making therewith four new experiments exactly like the first four in the above table. I was surprised to find results directly opposite to those before obtained; that is to say, the dusts furnished by bricks and tiles but little burned, gave results much inferior to those afforded by the dusts from well burned bricks and tiles. The experiments in the following table, were made with this cement.

Table XVII.

No. of the mortar.	Composition of the mortar.	No. of days required to harden in water.	Weight supported before breaking.
		days.	lbs.
1	Fat lime slaked to powder and measured in powder, 1 / Dust of tiles but little burned, 2 } 3	12	139
2	Lime the same, 1 / Dust of No. 1 reburnt for half an hour, 2 } 3	12	176
3	Lime the same, 1 / Dust of No. 1 reburnt for one hour, 2 } 3	15	282
4	Lime the same, 1 / Dust of No. 1 reburnt for two hours, 2 } 3	20	319

Observations on the experiments of Table No. XVII.

To make the experiments of table No. XVII, I took dust from the tile kiln which had given results opposite to those in table No. XVI, dust but lightly burned, and made mortars therewith, in its then state, and also after it had been reburnt.

Mortar No. 1 contains the slightly burned dust, and Nos. 2, 3 and 4 the same dust after it had been reburnt for the periods of time expressed in the table. According as the dust was burned more and more, the resistance increased; and it is probable it would have been further augmented by further burning. It should be noticed that the induration became slower as the resistance became greater. We shall see, below, that the slowness of the hardening is due to the dusts having been heated in crucibles, where they were out of contact of the air.

We see that the dusts of table No. XVI gave me good results only when they had been but little burned, while it was the contrary with those of table No. XVII. These opposite results led me to examine the composition of the clays of these two brick yards; and I ascertained that the clay which gave the dust of table No. XVII contained very little carbonate of

lime, while that which produced the dust of table No. XVI, contained almost a fifth of its weight of that substance. I repeated the experiment with the clays of several other tile kilns, and I always obtained this remarkable result, namely, when the clays contained little or no carbonate of lime, gentle burning imparted only mediocre qualities, while strong burning gave them excellent qualities. When, on the contrary, the clays contained from one to two tenths of carbonate of lime I procured good results only by heating lightly, and, if I augmented the degree of calcination the quality was impaired; and if the heat had been very great, all hydraulic property was lost. We see, consequently, that Mr. Vicat was in error in saying, as I have already quoted him at page 4, "that all the mystery of puzzalona resides, not in the presence of iron or lime, but in a particular state of combination of silex and alumine." It is certain, on the contrary, that the presence of lime in clays has a great influence on the quality of the puzzalona. At the same time we may conceive why those who had been engaged in producing this substance, were induced to announce, some, that it was necessary to heat clays but little, and others that it was necessary to heat them highly. It follows from what I have said that what was true of one kind of clay might not be true of another, although having the same aspect. We in no degree contest the point, for example, of Mr. Le Masson having obtained, at Rouen, very good results with a calcined ochreous earth; but had he submitted to the same degree of calcination an ochreous earth of the same appearance, but containing more or less lime, he would have had very different results. If two clays, equally greasy to the touch, be taken, of which one shall contain one fifth of lime, while the other contains none, and if they be equally heated, it may happen that neither of the results will possess hydraulic properties of any moment: that which contained the lime will have been too much burned, while that which was without lime will not have been burned enough. On the other hand if that containing lime be less burned and that having no lime be more burned, then very good results may be had from both.

The above experiments were made in the autumn of 1821. As they are the foundation of the fabrication of artificial puzzalonas, and as the important part that lime acts in this fabrication had not been noticed, I addressed, in 1822, to the Minister of War, a memoir containing the result of my experiments. An extract from this memoir may be found in the *Moniteur* of January 22nd, 1823.

Mr. Sganzin reports, page 31 of his *cours de construction*, that "they prepare at Amsterdam an artificial trass: it is clay taken from the bottom of the sea, which they burn highly as they do bricks. These brick-like pieces are broken by pestles worked by horses: the substance is then put under millstones, where it acquires the fineness necessary to be converted into mortar by mixture with lime.

"Bergman analysed this artificial trass, which bears the name of *privileged cement of Holland:* he found that it contained in about 100 parts Silex, from 55 to 60; Alumine, 19 to 20; Lime, 5 to 6; Iron, 15 to 20.

There is no doubt, considering the composition of this clay, and the degree of heat to which it is subjected, that it must give very good artificial trass.

I give below, in a table, some experiments on clay which I calcined after mixing with it a little lime.

Table No. XVIII.

No. of the mortar.	Composition of the mortar.		No. of days required to harden in water.	Weight supported before breaking.
			days	lbs.
1	Fat lime slaked to powder and measured in powder	1	12	319
	Dust from Holsheim clay	2 3		
2	Lime the same	1	23	169
	Same clay calcined with 0.10 of lime	2 3		
3	Obernai lime slaked to powder and measured in powder	1	10	440
	Dust of Holsheim clay	2 3		
4	Obernai lime do.	1	23	216
	Same clay calcined with 0.10 of lime	2 3		

Observations on the experiments of Table No. XVIII.

To make the above experiments, I slaked fat lime to dry powder, and fixed the quantity by measuring in powder: and I took Holsheim clay of which the composition is given at p. 378: vol. xx; it contains no lime. I calcined a portion of this clay in a crucible placed in a reverberatory furnace, keeping it at a redheat during twelve hours. I took the same clay, mixed it with one-tenth its volume of fat lime reduced to paste, and heated the mixture in the same way and for the same time, as the clay alone. I then made mortars 1 and 3 of the above table, mixing fat lime and the Obernai hydraulic lime, with the clay dust that contained no lime: the numbers 2 and 4 were made with the clay dust mixed with one-tenth of lime.

The results of the table show that the mortar made with fat lime, and clay dust containing lime, gave a resistance only one half of that obtained with same lime, and clay dust containing no lime. The table shows that I got like results with mortars made of Obernai lime. It will also be seen that the hardening was slower, by one half, with the dust containing lime, than with that without lime. Besides, these mortars took much more time to harden than they should have taken; this is owing to the clay dusts having been calcined in a crucible, and to the experiment having been made in winter.

Mr. Sganzin states, page 27 of his *cours de construction* that the officers of Engineers who constructed the sluice-bridge at Alexandria reburnt their brick dust to a high degree; and he says it was because, before this operation, the mortars melted (*se délayait*) in the water. Mr. Vicat also, mentions this process which he approves, but for another reason; his opinion is that energetic puzzalonas suit better with fat lime than with hydraulic lime; he has remarked that on highly heating puzzalona, it loses all its energy, and I have obtained the same effect. But the lime used in building the Alexandria bridge was Casal lime, which is eminently hydraulic. Mr. Vicat thinks, therefore, that the brick dust was calcined to diminish its energy, so that it might make better mortar with the Casal lime. This is a great error. The officers of Engineers in calcining this brick dust to a high

degree, committed a serious fault as I shall prove. But it is first necessary to show in what the error of Mr. Vicat consists. This Engineer relies on the principle, that mortar made of hydraulic lime, sand, and good cement, is superior to that made of lime and cement without sand. The first experiments of my table, Nos. 2 and 3, also show, that with good hydraulic lime, sand and trass or puzzalona, I obtained better results than with lime and trass or puzzalona without sand. But if we refer to table No. XIII, we shall see that, with a few exceptions, I obtained similar results with fat lime. If we compare the results of Nos. 9, 10, 11 and 12, all made of the same lime from marble, same trass and puzzalona, we see that if No. 9, containing sand, is inferior to No. 10, containing only lime and trass, on the other hand No. 11 which contains sand, is superior to No. 12 containing puzzalona without sand. To complete the conviction, it will suffice to cast the eyes over table No. XVIII; wherein we see that by the addition of one-tenth of lime to the Holsheim clay, and the degree of burning to which I submitted it, I considerably diminished the energy of this factitious trass: but it appears that this slightly energetic clay dust, gave, both with common lime, and with the Obernai hydraulic lime, a result only one half as good as that obtained with the same lime, and the clay dust in all its energy. The experiments cited, prove then, that energetic puzzalonas suit equally with very hydraulic lime and with fat lime. They prove that with these two kinds of lime it is in general more advantageous and economical to make mortars of lime, sand and puzzalona whether natural or artificial, than with lime and puzzalona only. If in certain cases, there is found to be a superiority in mortar without sand, we see that it is not great, and, on account of the considerable economy that results, we ought not to hesitate to use sand.

The observation cited by Mr. Sganzin, as to the sluice-bridge at Alexandria, would be entirely in opposition to the results Mr. Vicat and I have obtained by calcining clay dusts and puzzalonas to a high degree. We found that these substances thus calcined, lost all their energy, while, according to Mr. Sganzin, they require to be submitted to an elevated temperature. I did not doubt that Mr. Sganzin had been incorrectly informed as to what occurred at Alexandria; but, to be certain, I examined at the Depot of fortifications the documents relative to the works of that place, and I found, in a memoir of the *Chef de bataillon* Maynial, of the Engineers, dated 23 *brumaire an* 13, relating to this sluice-bridge what follows: The first season the floor (*radier*) was constructed of brick masonry in puzzalona mortar: the difficulty of procuring puzzalona, and its high price, led to the construction of a reverberatory furnace in which brick dust was reburnt to incandescence, so that when stirred it would flow like lava (*jusqu'a incandescence, de maniére que, lorsqu'on le remuait, on le voyait couler comme de la lave.*) The mixture of mortar, was one third of this reburnt brick-dust, one third sand, and one third Casal (lime,) and it produced the same effect as a like mixture of puzzalona."

We see that it was the difficulty of procuring puzzalona, that gave the idea of reburning the clay dust to the point of fusion, and that they were led to this degree of calcination by the false notion that puzzalona was lava—these two substances, being in fact, very different. It is not said in the memoir that the mortar made of this dust, before reburning it, melted in water, as Mr. Sganzin states: and it could not have been so, since they used the Casal lime, which is very hydraulic. We see, moreover, that it was not with a view to diminish the energy of the cement, and because

it was to be used with very hydraulic lime, that it was reburnt; on the contrary they wished to impart to it the force of puzzalona, which they imagined had been melted like lava. The memoir says that this recalcined dust, produced the same effect as a like mixture of puzzalona. If they had mixed it with fat lime, there would have been a great difference between the results with this dust and those obtained in the same way with puzzalona. It is evident that their result ought to have been good, as it is stated to have been, at the end of the memoir, but it was owing entirely to the Casal lime being so eminently hydraulic. We have seen in the first tables that very hydraulic limes gave very good resistances without any admixture: if they had been mixed with broken nut shells, or with chopped straw, we should still have had a good result, but it would have been very wrong to attribute the result to those substances. By reburning the brick dust at so high a heat, they destroyed all its hydraulic properties; and they would have had as good a mortar by mixing this very hydraulic lime with sand, instead of the dust they used; and at a much cheaper rate. I repeat then that they committed a great fault at Alexandria in reburning the clay dust thus highly, since they necessarily caused it to part with all its hydraulic properties, and, in order to do this, encountered great expense. Before calcining the dust, if they thought proper to use it, they should have tried it with a little fat lime, to ascertain whether, or not, it would be advantageous to burn it more. I have enlarged on this example of the works of Alexandria, to show how important it is not to have false ideas as to puzzalonas, or the substances which are substituted for them. I proceed now to repeat other experiments that I made with diverse clays mixed with lime and calcined to different degrees.

Table No. XIX.

No. of the mortar.	Composition of the mortars.	The clay having been burnt with lime.		The clay having been burnt with bricks.	
		H	W*	H	W
1	Fat lime slaked to powder & measured in powder 1 / Trass 2 — 3	days	lbs.	days	lbs.
2	Lime the same 1 / Puzzalona 2 — 3				
3	Lime the same 1 / Dust of Holsheim clay 2 — 3	25	187	15	275
4	Lime the same 1 / Dust of Holsheim clay with lime water 2 — 3	25	143	15	286
5	Lime the same 1 / Dust of Holsheim clay with 0.01 of lime 2 — 3	25	165	15	297
6	Lime the same 1 / Dust of Holsheim clay with 0.02 of lime 2 — 3	30	110	10	319
7	Lime the same 1 / Dust of Sufflenheim clay 2 — 3	25	165	15	297
8	Lime the same 1 / Dust of Sufflenheim clay with lime water 2 — 3	25	220	15	286
9	Lime the same 1 / Dust of Sufflenheim clay with 0.01 of lime 2 — 3	25	143	15	286

*In this table and several others which follow, the columns marked H, express the number of days the mortar required to harden in water, and those marked W, indicate the weights supported before breaking. Au.

Table No. XIX.—(Continued.)

No. of the series.	Composition of the mortars.			The clay having been burnt with lime.		The clay having been burnt with bricks	
				H	W	H	W
10	Lime the same Dust of Sufflenheim clay with 0.02 of lime	1 2	3	25	121	12	275
11	Lime the same Dust of pipe clay	1 2	3	25	264	15	308
12	Lime the same Dust of pipe clay with lime water	1 2	3	25	264	15	330
13	Lime the same Dust of pipe clay with 0.01 of lime	1 2	3	25	275	15	341
14	Lime the same Dust of pipe clay with 0.02 of lime	1 2	3	25	275	12	363

Observations on the experiments of Table **No. XIX.**

To make the above experiments I took three kinds of clay, that of Holsheim, of Sufflenheim, and the pipe clay of the environs of Cologne: the composition of these clays may be seen at p. 378, vol xx. I made four bricks of each of these clays: the first contained no foreign substance: the second was made by adding a quantity of lime water equal to the bulk of clay; the third by adding one per cent. of fat lime in paste, and the fourth by adding two per cent of the same lime; they were placed in a lime kiln in the midst of the lime.* With each of the same clays I made, also, four other similar bricks which I placed in the same kiln with the common bricks. Lastly, having calcined these cements, I made the mortars which are given in the table, taking one part of fat lime, measured in powder, to two parts of each of these cements. No. 1 and 2, were made of the same lime and trass or puzzalona, to serve as comparisons with the other experiments. The mortar of trass hardened in six days, and broke under a weight of 264 lbs: that of puzzalona hardened in four days and supported 352 lbs. before breaking. The hardening has in general been a little slower; although these experiments were made at the end of summer. That may possibly be owing to the degree of burning of the lime.

On examining the above table we shall remark that all the clays that were burned with the lime, including the natural clays, gave results, less good, than when burned with the bricks; this difference is much greater with the clays which contain lime; we see that when burned with the bricks the Holsheim clay, and the pipe clay, gained a little by the addition of a small quantity of lime, while the Sufflenheim clay, on the contrary, lost a little. When they were burned with the lime, the Holsheim clay lost strength; that of Sufflenheim presented anomalies which I cannot explain, and the pipe clay was but little changed.

The Holsheim clay being most at command. I made with it several mixtures of lime up to one tenth. and I burned them in the same way as the above clays: the following table contains the results.

*Throughout all Alsace, they burn lime in large square, and elevated kilns, lime is put at bottom, bricks are placed above the lime, and tiles above the bricks: they burn with wood, which is placed at the bottom: so that the lime is most highly heated, and the tiles the least. Au.

Table No. XX.

No. of the series.	Composition of the mortars.	Clay burned with lime.		Clay burned with bricks.	
		H	W	H	W
		days	lbs	days	lbs
1	Fat lime measured in paste . 1 Trass . . . . 2 } 2				
2	Lime the same . . . 1 Puzzalona . . . . 2 } 3				
3	Lime the same . . . 1 Dust of Holsheim clay . . 2 } 3	25	253	15	396
4	Lime the same . . 1 Dust of Holsheim clay with 0.01 of lime . . 2 } 3	25	209	15	319
5	Lime the same . . . 1 Dust of Holsheim clay with 0.02 of lime . . 2 } 3	25	242	15	297
6	Lime the same . . . 1 Dust of Holsheim clay with 0.03 of lime . . . 2 } 3	25	231	15	286
7	Lime the same . . . 1 Dust of Holsheim clay with 0.04 of lime . . 2 } 3	25	253	15	341
8	Lime the same . . . 1 Dust of Holsheim clay with 0.05 of lime . . 2 } 3	25	275	15	352
9	Lime the same . . . 1 Dust of Holsheim clay with 0.06 of lime . . 2 } 3	25	231	15	297
10	Lime the same . . . 1 Dust of Holsheim clay with 0.07 of lime . . 2 } 3	25	198	15	275
11	Lime the same . . . 1 Dust of Holsheim clay with 0.08 of lime . . 2 } 3	25	198	15	286
12	Lime the same . . . 1 Dust of Holsheim clay with 0.09 of lime . . 2 } 3	25	231	15	297
13	Lime the same . . . 1 Dust of Holsheim clay with 0.10 of lime . . 2 } 3	25	242	15	286
14	Lime the same . . . 1 Dust of Holsheim clay with 0.04 of lime . . 2 } 3			4	187
15	Same mortar			4	209
16	Same mortar			3	297
17	Same mortar			3	385

Observations on the experiments of Table **No. XX.**

The above experiments were made in the same manner as those of table No. XIX, as to the burning of the clays; but in proportioning the mortars I took one part of lime in paste to two parts of cement. I made two comparative experiments, No. 1 and No. 2 with trass and puzzalona. The mor-

tar with trass hardened in four days and supported 319 lbs; that with puzzalona hardened in three days and broke under a weight of 286 lbs. We have seen in table No. XIII, an exactly similar mortar support 495 lbs. Whence it appears that with puzzalona as with trass, results are various.

The present table concurs with No. XIX in showing that the cements calcined with the lime gave inferior results to those calcined with the bricks. This table shows also that the proportions of lime mixed with the clay, which gave the best results for the degrees of calcination tried, were four or five per cent; but here, the best result obtained from clay mixed with lime, is inferior to that of No. 3 where there was no lime. It appears that the mortars of the two tables whereof the clay had been calcined with 0.02 of lime do not greatly differ. A greater difference observable between the mortars No. 3 of the two tables, neither of which contain lime, may be owing to two circumstances: the first is, that in table No. XIX the proportions were adjusted with lime in powder, while in No. XX, they were fixed with lime in paste; the second is, that the cement of mortar No. 3 in the present table may have received a more suitable degree of calcination than that of table No. XIX.

All the four mortars No. 14, 15, 16 and 17 were made with clay that had been mixed with 0.04 of lime, but they were heated to different degrees in another kiln, and gave different results. Cement No. 14 was burned with the tiles and placed in the upper part; No. 15 was placed in the middle of the kiln; No. 16 between the tiles and the bricks, and No. 17 in the middle of the bricks. Whence it appears that No. 14 was least and No. 17 most heated. This last mortar gave about the same resistance as No. 3 which contained no lime.

There are several anomalies in the last column of table No. XX which appear to me to be due to the degree of calcination. We notice, in fact, that in a brick kiln, not only the different layers sustain different degrees of heat, but even the bricks in the same layer are not all burned to the same degree. All the mortars of the last column of the last two tables, required about fifteen days to harden, with the exception of the last four which hardened in the short space of three to four days. I attribute this effect to the circumstance that these four cements were placed by the side of one of the flues left in the mass of bricks in order to distribute the heat; and thus they were exposed, during the burning, to a current of air which contributed to the promptitude of the induration, as I shall have occasion to show

The experiments given in tables Nos. XVI, XVII, XVIII, XIX and XX, show that the presence of lime has great influence, when it exists in the state of carbonate in the clays, as to the effect of calcination upon them; because the heat disengages a great part of the carbonic acid, and the lime mixed in the clay, causes the beginning of vitrification, which is distructive of all hydraulic properties in these cements. These experiments show, besides, 1st. that clay containing no lime requires a rather high calcination to form good artificial puzzalonas, and that the heat required to burn bricks suitably, is about the proper degree for such cements: 2nd. that when the clays contain as high as one tenth of carbonate of lime, the temperature used to burn tiles is sufficient: 3rd. that this degree of heat is too great for them, provided they contain from a tenth to a fifth of carbonate of lime, as sometimes happens, but that good results may still be got by burning them with a lower heat than that required for tiles: 4th. it does not appear that the presence of lime in clays tends to make the cements more ener-

getic. If it gives energy to some clays, it is but slight: and there may result from the mixture, if the burning be carried too high, a loss of all hydraulic property. At the close of the chapter I shall explain all the means necessary to the fabrication of good artificial puzzalona.

Among the substances which, after lime, occur most frequently in clays, is magnesia. I, in consequence, made the following experiments with Holsheim clay and various proportions of carbonate of magnesia.

Table No. XXI.

No. of the mortars	Composition of the mortars.		No. of days required to harden in water.	Weight supported before breaking.
			days.	pounds.
1	Fat lime measured in paste Dust of Holsheim clay	1 2 } 3	20	330
2	Lime the same Dust of the same clay with 0.01 of carbonate of magnesia	1 2 } 3	20	341
3	Lime the same Dust of the same clay with 0.03 of do.	1 2 } 3	20	330
4	Lime the same Dust of the same clay with 0.05 of do.	1 2 } 3	20	341
	Lime the same Dust of the same clay with 0.07 of do.	1 2 } 3	20	330
6	Lime the same Dust of the same clay with 0.10 of do.	1 2 } 3	20	330
7	Lime the same Dust of the same clay, highly heated, with 0.05 of carbonate of magnesia	1 2 } 3	20	231

Observations on the Experiments of Table No. XXI.

I made the above mixtures of Holsheim clay with carbonate of magnesia in the same manner as, in the preceding tables, the mixtures of clay and lime. We see that the hardening was slower than usual; but this is owing to the experiments having been made during very cold weather in the month of January.

These clays were placed in the lime kiln between the bricks and the tiles, and we see by the result of No. 1 that the degree of heat was not quite sufficient to impart to this clay all the energy of which it is susceptible. We see also, that at this degree of heat, the carbonate of magnesia has had no great effect in transforming this clay into puzzalona. The cement No. 7 was more highly heated, being placed between the bricks and the lime: the clay of this number contained the same quantity of carbonate of magnesia as No. 4 and we see that it supported 110 lbs. less. We should not conclude that this effect is due to the magnesia; because the Holsheim clay loses, when alone, much of its force when too highly heated, as we see by No. 1 of table XXIII. It appears, therefore, that magnesia is nearly passive in the perfecting of artificial puzzalonas.

Clay, we know, is a mixture of silex and alumine: I, in consequence, made the following experiments, adding sand to the clay which I heated.

Table No. XXII.

No. of the mortars.	Composition of the mortars.			No. of days required to harden in water.	Weight supported before breaking
				days	lbs.
1	Fat lime slaked to powder and measured in powder	1	3	12	418
	Dust of pipe clay heated for six hours in a reverberatory furnace	2			
2	Lime the same	1	3	14	374
	Same clay deprived of part of its sand, and to which was added 0.10 of white sand pounded fine	2			
3	Lime the same	1	3	15	378
	Dust of clay No. 2 with 0.20 of sand do.	2			
4	Lime the same	1	3	15	383
	Dust of clay No. 2 with 0.30 of sand do.	2			
5	Lime the same	1	3	15	473
	Dust of clay No. 2 with 0.40 of sand do.	2			
6	Lime the same	1	3	15	462
	Dust of clay No. 2 with 0.50 of sand do.	2			
7	Lime the same	1	3	16	187
	Dust of yellow ochreous clay	2			
8	Lime the same	1	3	20	143
	Dust of yellow ochreous clay, deprived of part of its sand	2			
9	Lime the same	1	3	20	165
	Dust of clay No. 8 with 0.10 of white sand pounded fine	2			
10	Lime the same	1	3	18	176
	Dust of clay No. 8 with 0.20 of sand do.	2			
11	Lime the same	1	3	16	189
	Dust of clay No. 8 with 0.30 of sand do.	2			
12	Lime the same	1	3	18	154
	Dust of clay No. 9 with 0.40 of sand do.	2			
13	Lime the same	1	3	20	132
	Dust of clay No. 8 with 0.50 of sand do.	2			
14	Lime the same	1	3	12	352
	Dust of clay called Rintzel	2			
15	Lime the same	1	3	10	418
	Dust of Rintzel clay deprived of part of its sand	2			

Observations on the experiments of Table No. XXII.

To make the first six experiments, I took the white clay which is sent from the environs of Cologne to Strasburg, to make pipes. The analysis of this clay, given in vol. xix, p. 378, shows that it contains very little iron, and that the alumine in it, is about one third of the silex. I took a portion of this clay, diffused it through a large quantity of water, and decanting it several times, deprived it of a part of its silex. I then made the mortar No. 1 with the natural clay: the other mortars up to No. 6 inclusive were composed with the clay deprived of part of its silex, to which I added, successively, the portions of sand stated in the table. The sand which I used was white and silecious: it was pounded very fine and mixed with the clay.

I omitted composing a mortar of lime, and this white clay deprived of

part of its sand, like that, No. 8, made of another kind of clay. The clay of the first six numbers was calcined during six hours in a reverberatory furnace. No. 2, which had less sand than No. 1, gave a result less strong. The quality of the succeeding mortars improves up to No. 5, to which I had added 0.40 of sand; No. 6, which contained 0.50 of sand, was inferior to No. 5.

The experiments from No. 7 to No. 13 were made with a very greasy clay: a yellow ochreous earth of which I had not the analysis. I treated this clay like the other, that is to say, I took a portion which I washed in a great quantity of water, decanting several times to separate a portion of the sand it contained. No. 7 was made with the natural ochreous earth: No. 8 with the clay deprived of a portion of its sand. To make the following mortars up to No. 13, I added to the washed clay the several portions of sand indicated in the table; these clays, like the pipe clay, were heated for six hours in a reverberatory furnace, keeping them at a low red heat (*rouge tendre.*) We see that, with this clay as with the pipe clay, we obtained an inferior result when it was deprived of much of its sand, and that its energy was augmented by adding a little sand, up to a certain quantity, beyond which it went on diminishing. The comparison of the above experiments with ochreous clay and pipe clay, shows that ochreous earths are not, as was for a long time believed, to be preferred in forming artificial puzzalonas: several other results confirm this remark.

The experiments No. 14 and 15 were made with a clay which is found in the environs of Haguenace, and is used for various purposes; this clay is gray, and contains no lime: it is refractory. It is used in the construction of furnaces for heating madder. On working it in the hands, it is perceived to contain a considerable quantity of sand. No. 14 is composed of the natural clay: in No. 15, the clay is deprived of part of its sand, and in this state it is much more greasy to the touch. A comparison of No. 14 and 15 shows that this clay gave the best result when deprived of part of its sand.

The experiments made with the above three kinds of clay prove that clays containing a great quantity of sand are not so suitable for making artificial puzzalonas as those which, having more alumine, are greasy to the touch. When clays contain one part of alumine to three of silex, they are very greasy: they are also quite greasy when the proportion is one to five, but beyond this they become meagre: it is therefore amongst the clays a little greasy, that we should seek for those whereof to make artificial puzzalona.

We have seen, according to the analysis, by Mr. Berthier, of trass and puzzalona, that these substances contain potash and soda. I therefore mixed these with the clays to be heated, and the following are the results.

Table No. XXIII.

No. of the mortar.	Composition of the mortars.		Clay having been burned with bricks.		Clay having been burned with lime.	
			H	W	H	W
			days.	lbs.	days.	lbs.
1	Fat lime measured in paste Dust of Holsheim clay	1 2 } 3	15	330	25	99
2	Lime the same Dust of same clay with 1-10 of solution of soda at 5°	1 2 } 3	15	319		
3	Lime the same Dust of same clay with 1-5 do.	1 2 } 3	15	308		
4	Lime the same Dust of same clay with 1-4 do.	1 2 } 3	15	297		
5	Lime the same Dust of same clay with 1-3	1 2 } 3	15	297		
6	Lime the same Dust of same clay with 1-2	1 2 } 3	15	286	15	297
7	Lime the same Dust of same clay with 1-10 of solution of potash at 5°	1 2 } 3	15	341		
8	Lime the same Dust of same clay with 1-5 do.	1 2 } 3	15	363		
9	Lime the same Dust of same clay with 1-6 do.	1 2 } 3	15	374		
10	Lime the same Dust of same clay with 1-3 do.	1 2 } 3	15	363		
11	Lime the same Dust of same clay with 1-2 do.	1 2 } 3	15	341	25	264
12	Lime the same Dust of same clay with 1-2 of solution of saltpetre at 5°	1 2 } 3		(*)	25	264
13	Lime the same Dust of same clay with 1-2 of solution of saltpetre at 10°	1 2 } 3			25	242
14	Lime the same Dust of same clay with 1-2 of solution of com. salt at 5°	1 2 } 3	15	330	25	264

Observations on the experiments of Table No. XXIII.

To make the above experiments I took Holsheim clay and mixed it with various quantities of solutions of soda standing at 5° of the *pèse acid.* The quantities of solutions of soda that the clays contain are taken with reference to the volume of clay. I did the same with potash, as is shown in the numbers from 7 to 11. Nos. 12 and 13 have the clay mixed with water containing saltpetre; and No. 14 has the clay wet with salt water.

The clays of the first eleven numbers of the first column of the table were heated in a lime kiln, between the tiles and the bricks, so as to give them only a moderate heat. Those of No. 1, 6 and 11 of the second column were burned with the lime, and subjected to a very high heat.

If the result of the first eleven numbers, wherein the clay was heated with bricks, be observed, it will be seen that the first of those which con-

*This mortar broke, on being cut, but was very hard. Au.

tain soda, differ but little from No 1 which contains none, but that the resistances, in the succeding numbers, go on diminishing a little, as the proportion of soda was increased. With potash, I obtained a different result; the resistance of the mortars augmented up to No. 9, and afterward diminished. The clays placed between the tiles and the bricks received a degree of heat rather too slight—for No. 1 supported a weight of only 330 lbs, while we have seen that this clay could sustain a weight of 396 lbs, when the clay had been properly calcined.

The clays No. 1, 6 and 11, which had been placed in the middle of the lime, received a much higher degree of heat than ordinary: for the cement No. 1 had become of a slate blue, while it is commonly of a liver colour (*d'un rouge foncé*) a good deal like the puzzalona that I used.

We see that mortar No. 1 lost much of its strength when its cement had been calcined with the lime, since, instead of 330 lbs, it supported only 99 lbs: but it is singular that Nos. 6 and 11 which had received the same degree of heat, and of which the cements were equally blue, offered a resistance much greater than the corresponding one of No. 1. The effect of soda and potash, then, has been to prevent this clay from losing a great part of its hydraulic property in consequence of a too high calcination. I thought I should obtain an opposite result, because these substances, heated with silex, form glass, and all vitrified substances make very bad puzzalonas. But these gave no trace of vitrification. I obtained a slight advantage by moistening the clay with the lye of ashes standing at 5°.

No. 12 and 13 are composed of the same clay tempered with water containing saltpetre (nitrate of potash.) This trial was made in duplicate; the cement in one being but little, and in the other, much burnt. Unfortunately the first mortar broke on being cut to the proper size; the second experiment gave a good result, like that obtained from potash. This trial was designed to ascertain whether the *aqua-fortis cement*, which has been a long time in use, merits its high reputation. This cement is an argillaceous residue, derived from distillation of nitrate of potash and clay, to extract nitric acid. This operation is performed in matrasses of stoneware or glass: the residue being a combination of ferruginous clay, potash and some alkaline salts. Being pulverized, this is what is called *aqua-fortis cement (le ciment a l'eau-forte.)* Very good results are got from it. But I presume, after what has been shown above, that the quality of the cement must be very variable, according to the composition of the clays used, and especially, as they may sometimes contain lime. It is unfortunate that the mortar No. 12, of which the clay had been moderately calcined, was broken. We see that the trial, in the case where the clay had been highly calcined, gave an average result. No. 13 only differed from No. 12, in being mixed with water more highly charged with nitrate of potash. The experiment of No. 13 having given a result sensibly superior to the No. 1 corresponding, I am induced to think that the *aqua-fortis cement* may be very good; but these experiments should be repeated.

I have stated above that the Dutch make a very good factitious trass, by calcining a clay which they extract from the bottom of the sea; I, consequently, made No. 14, of the Holshiem clay, and salt water. If we compare No. 14 of the first column and the corresponding No. 1, we see that the result is the same. If we make the same comparison in the second column, which comprises the clays calcined with the lime, we shall remark that the clay mixed with salt water has a great superiority. We have a right to conclude then that the marine salt acted like the potash and soda—

that is to say, it prevented a high degree of calcination from depriving the clay of a great portion of its hydraulic property. It results from this, that when fabricating artificial puzzalonas near the sea, it will be proper to try whether, on mixing the clays with salt water, the bad effects of too high a heat will be prevented. This would be advantageous, because it is difficult to give an equal degree of heat to a kiln, when the temperature is high. These experiments should be made at different degrees of temperature, so as to compare results. Even in the interior of the country, it would not be expensive to add salt to the clays which are to be calcined—using a solution of common salt.

Although, according to table No. XXIII, soda, mixed with Holsheim clay, gave results a little inferior to those given by the natural clay, it was not so with potash. When the proportions were not too great, potash gave results sensibly better. This resort cannot always be had, because of the cost of the materials, and of the operation of mixing. I shall show in the sequel that it is easy to arrive at the same end in a less expensive mode, by choosing proper clays; but the observation of the effects of potash will serve to throw some light on the theory of puzzalona and trass.

The hardening of the mortars in the above table was rather slow; one of the causes was, that the experiments were made in the beginning of winter. The mortars of the first series all took about fifteen days to harden, and those of the second, twenty-five days.

I now proceed to give the results obtained with the dust of clays found near Strasburg, or carried thither for various uses.

Table No. XXIV.

No. of the mortar.	Composition of the mortars.	No. of days required to harden in water.	Weight supported before breaking.
		Days.	lbs. lbs.
1	Fat lime, sand and trass	4 to 20	231 to 510
2	Do. and Trass	3 to 16	264 to 583
3	Fat lime, sand and puzzalona	4 to 5	352 to 499
4	Do. and puzzalona	3 to 5	286 to 550
5	Do. sand, and dust of Frankfort clay	4 to 6	418 to 561
6	Do. and dust of Frankfort clay	3 to 5	422 to 578
7	Do. sand, and dust of Cologne clay	14 to 18	286 to 473
8	Do. and dust of Cologne clay	12 to 15	308 to 495
9	Do. sand, and Dust of Wissemburg clay	14 to 16	242 to 429
10	Do. and dust of Wissemburg clay	12 to 15	220 to 462
11	Do. sand, and dust of Holsheim clay	12 to 18	253 to 418
12	Do. and dust of Holsheim clay	10 to 15	275 to 440
13	Do. sand, and brick dust of Sufflenheim	16 to 20	231 to 407
14	Do. and brick dust of Sufflenheim	15 to 18	253 to 462
15	Do. sand, and dust of Kilbsheim clay	10 to 12	231 to 308
16	Do. and dust of Kilbsheim clay	8 to 10	253 to 319
17	Do. and dust of whitish bricks of Ackenheim	12 to 15	242 to 286
18	Do. and dust of red bricks of Ackenheim	25 to 35	77 to 121
19	Do. and dust of yellow bricks of Kehl	25 to 40	55 to 77
20	Do. and several kinds of dust from Depot	10 to 30	121 to 330
21	Do. and slate dust	12 to 15	319 to 451
22	Do. and "*ciment de sanguine*"	15	352
23	Do. and dust of yellow ochre	18	297
24	Do. and two parts of Paris cement	4	187*
25	Do. sand, and Paris cement	5	99*

*These two mortars were cracked.

Observations on the experiments of Table No. XXIV.

I have united in the above table several trials to produce hydraulic mortar with fat lime and different kinds of clay calcined, without adding any thing to them. At the top of the table, I put the results obtained with trass and puzzalona. I have united all the experiments of the same kind in a single statement, because I sometimes made the mortars by taking the lime in a powder, and sometimes in paste. The proportions of sand, trass and cement, also varied. We see that it would have required a very extended table to separate all these experiments. By uniting them, as I have done, the general result may be seen.

No. 1 comprises mortars composed of various fat limes, sand and trass; several causes contributed to vary the hardening and the resistance: these are, principally, the quality of the trass; the time it was left in the air after being slaked with a little water; the proportion, and, lastly, the season of the year. This observation applies to all the following mortars. The weakest resistance of the mortars No. 1, is 231 lbs., and the strongest 510 lbs.

No. 2 comprises a series of experiments made with fat lime and trass, without sand, the resistance varied from 264 to 583 lbs.; this last result is the greatest that I obtained in all my experiments. This mortar was made in summer, with lime that had been slaked to powder for two months; it is probable that the piece of trass was of an unusually good quality.

The two series of experiments under Nos. 3 and 4, were made with fat lime, sand and puzzalona; and with lime and this last substance without sand. The puzzalona behaved like the trass. From the column showing the hardness, it might be supposed that the puzzalona mortars hardened quicker than those made of trass, but it is not so. In the instances of the trass, the mortars were made in winter as well as in summer; but with the puzzalona, the experiments were made only in summer, and during that season, the hardening was about the same for the two substances. There is, however, a light advantage in favor of puzzalona, but which cannot be estimated at more than half a day. I therefore, as stated above, regard these two substances as having given me like results.

Nos. 5 and 6, comprise experiments made with clay brought from a village called Kinglesburg, twelve leagues from Frankfort; this clay is used at Strasburg to make alum; it is preferred to the clays of the vicinity because it contains almost no iron; they calcine it for thirty-six hours before dissolving it in sulphuric acid. When this clay is in its crude state, it is blackish, owing to vegetable remains. By calcining it a little, it becomes blue; in which state it gives bad results; when strongly calcined, it becomes very white, and forms an excellent artificial puzzalona, as appears from those two numbers, 5 and 6. The analysis of this clay shows that it contains no lime, and the iron found in it in small quantity may be considered as without action. It has been an error, therefore, to attribute great influence to iron in the improvement of artificial puzzalonas: these experiments, 5 and 6, showing that a very good artificial puzzalona may be obtained from a clay containing neither iron nor lime. The analysis of this clay exhibits the alumine as existing in the proportion to the silex, of about three to five, (see vol. xx, p. 378:) it is very greasy to the touch. Mortars made of this cement and sand, sometimes gave superior results to those in which there was no sand, and sometimes inferior, as happened with trass. The hardening was always as quick as with puzzalona; which I shall explain in the sequel.

The series Nos. 7 and 8, were made of the white clay which is brought from Cologne to Strasburg to make pipes. We see, at page 378, vol. xx, that it contains no lime and very little iron. The table shows that the mortar made of this cement gave very good results also, although the clay does not contain as much alumine as that from Frankfort; the hardening was slower.

The mortars Nos. 9 and 10, were composed of clay from the environs of Wissemburg; it is used at Strasburg to make common pipes. This clay contains no lime; it is, as it were, marbled with veins of red oxide of iron; the analysis indicates but little more iron than the Cologne clay, but it is because the specimen analysed was taken from between the veins. The table shows the results to have been very good.

The series Nos. 11 and 12, were made of Holsheim clay; which contains no lime, but a quantity of iron; it is of a reddish color, and quite greasy to the touch, although the proportion of alumine to the silex is hardly one to four. The dust of this clay gave very good results, but the hardening was slow.

The series Nos. 13 and 14, were made of bricks of Sufflenheim, of which the clay contains no lime, but a considerable quantity of iron; it is not very greasy, and, indeed, the alumine is only about one seventh of the silex. The cement of which I made the several mortars, were made from bricks which I reduced to powder; we see that these results are also very good.

The series Nos. 15 and 16, were made of Kolbsheim bricks; the clay of this kiln is quite greasy—containing one of alumine to four of silex. It contains a considerable quantity of iron, and more than one tenth of lime; the results were not so good as with Holsheim and Sufflenheim cements. The trials were made with brick dust; I did not make many, and it is possible that I used bricks that had been too much burned.

Nos. 17 and 18 were made of the dust of Achenheim bricks. No. 17, of the dust of a whitish brick, containing but little iron and little lime. The results were pretty good. No. 18 was made of the dust of bricks which are very red—containing much iron, and a great quantity of lime. The mortars of this cement were very bad. I am not certain whether the bricks of No. 17 were made of clay from Achenheim itself, or its environs.

The experiments under No. 19, were made with yellow bricks from Khel. I do not know the analysis of this earth, but it is a yellow ochreous earth, containing a considerable quantity of lime; we see that I got bad results, only.

The series No. 20, was made with various cements taken from the place of deposit of a contractor—being derived from a mixture of various tiles and bricks. We see that I had sometimes good results, and sometimes quite bad; as might be expected from the manner in which the cements were composed.

The experiments under No. 21, were made of slates from the neighborhood of Mayence. I do not know the analysis, but being assured that they contain little or no lime, I calcined them highly, and they gave me a very good cement. I had occasion to notice that, to obtain a good result, it was necessary to calcine these slates until they began to take a light red color on cooling, which requires quite a high heat. I am surprised that in the experiments of Mr. Gratien, senior, at Cherbough, better results were not obtained; this appears to me to have been owing to the degree of burning, which they did not sufficiently vary, to ascertain the best. I presume that good cements could be made of the tender strata found near the surface of the slate quarries, and which are too tender to be formed into slates. They will be easier to reduce to powder after calcination.

No. 22 was made of a cement obtained from a substance known under the name of "*sanguine;*" the resistance of this mortar was quite good.

Mortar No. 23 was made of cement resulting from the calcination of a clay known by the name of yellow ochre; the result was less than that of the preceding mortar. It appears to me that the yellow ochreous clays are not so good as others for the production of artificial puzzalonas; it is possible it may be owing to the oxide of iron being found therein in combination with the silex, as shown by Berzelius.

In the *Annales de Chimie* of 1824, it is stated that in 1823, Mr. Saint Leger made factitious puzzalona at Paris from the clay of Passy and Meudon, in the proportion of three parts of these clays to one of lime slaked and measured in paste. In 1825, I made two mortars of some cement given me by Mr. Saint Leger. Mortar No. 24 is an experiment therewith; it was made of one part of fat lime measured in paste, mixed with two parts of this cement: this mortar hardened promptly. At the end of a year, I submitted it to rupture, with the others; but it was cracked, and supported only 187 lbs.

No. 25, was made of the same lime, of sand, and of cement, in equal parts; this mortar hardens promptly; but it, also, was cracked, and bore only the light weight of 99 lbs. We shall see, in the second section, that I made of this cement a mortar which was exposed in the air for one year, and that it had so little consistence, that it crumbled easily in the fingers.

The bad results that I obtained from the cements of Mr. Saint Leger seem to be due to the quantity of lime which they mix with the clay in making the cement. I said in my memoir of 1822, of which an extract is contained in the Moniteur of January 22, 1823. "The substance of which it is most important to observe the proportions, is lime. If the argillaceous earth used contains a tenth, or more, of lime, and it be heated to the degree necessary to burn bricks properly, the trass obtained will be very bad; if this earth be heated to the degree employed to burn those bricks which are called *light burned bricks*, the trass will be of a mediocre quality only, but may be used in works not requiring prompt induration. It appears that a very small quantity of lime, as four or five per cent, in the clayey earths, far from injuring the quality of the puzzalona or trass, brings, on the contrary, the clay to that condition that the cement produced will cause the mortar to harden very promptly, and at the same time impart to it a high degree of force. When there is no lime in clay, a higher burning is required and the hardening is rather slower."

In 1822, therefore, I regarded lime as a substance to which the greatest attention should be paid, when it was found to be a natural constituent of the clays to be turned into puzzalonas; but that I considered it rather to be avoided than sought after; observing, nevertheless, that a small percentage of this substance was rather useful than injurious, with proper care in managing the heat. The expense of mixing lime with clays that are to be converted into puzzalonas, should, therefore, be avoided.

On mixing fat lime slaked to paste, with clay, I have observed a singular phenomenon, for which I have not been able to account: it is this, if clay be diffused through water, till we bring it to the consistence of clear sirup, and, after having brought the lime to the same state, the two mortars be mixed together, as soon as the mixture is made, it becomes so thick that it will be difficult to continue the operation without adding a considerable quantity of water. I do not know to what this is owing.

The results of experiments 18, 19 and 20, show how dangerous it would

be to use, without examination, the first cements encountered. I will cite an example in point. When Marshal Vauban built the citadel of Strasburg, three great casemates were constructed in each of the two bastions which lie on the town side. The casemates of the right bastion are very dry, and they are often used as powder magazines. The casemates on the left were, on the contrary, very wet; the water filtered, every where, through the arches; all the casemates had caps of cement, but those of the right had been made of good, and those of the left, of bad cement. In 1808, they were obliged to make the caps of the casemates on the left anew. On breaking up the old caps, it appeared that they had been made of cement, (brick dust?) but that moisture had penetrated for a long time, and that several parts had scaled off. In the report on the reconstruction, it is said, "We followed vigorously, in the execution of this work, the method indicated by Mr. Fleuret. The cement was made under the supervision of a workman employed by him, and it was put on by masons practised in this kind of work. The thickness of the cap was two and four-tenth inches, and was composed of three layers of cement, applied successively with the trowel, and compacted by ramming. The last course was rammed, and afterwards polished off with a stone, until the cement had acquired such hardness as to receive no further impression." (Report of Captain Gleizes of the Engineers, January 30, 1808.)

We see that it was no want of precautions that caused the work to fail. Notwithstanding these precautions, the water, after ten years, filtered through every part of these arches, and they were again, necessarily, remade. On demolishing them a second time, it was observed that several portions of the three layers of mortar that had been successively placed to form the caps, had no connexion with each other. I think it is a great fault to make the caps of arches in successive layers; they should, in my opinion, be made of a single one, let the thickness be what it may. Mr. Fleuret attaches great importance to beating mortars well, and we shall see further on, that this is also an error. The caps at Strasburg failed the second time because they used fat lime, and brick dust? taken at hazard; it was found to have no hydraulic property, and the mortar had no consistence. Mr. Fleuret succeeded very well in making factitious stones, and water pipes, when he used the Metz lime; but a contractor at Phalsbourg who attempted to apply this process to the construction of the military fountain—using the materials of the country, failed in his work, and was ruined. At Landau, also, the caps of arches made according to the process of Mr. Fleuret, failed. The caps of the above casemates of Strasburg were constructed in 1819, with good materials: they succeeded well, and the casemates have become very dry. I thought it my duty to give these details to show how important it is not to use cements without a previous trial, because it is always an expensive substance, and if badly chosen, it may happen that the result is no better than if so much sand had been used instead thereof.

I am now about to state how I detected an important action exercised by the air in perfecting artificial puzzalonas. We may remark that all the experiments made with Frankfort clay, hardened very quickly, and gave great resistance. I took these clays from a certain furnace where they had been calcined for the purpose of making alum. Having, one day, burnt in a lime kiln, some bricks made of this clay, I was surprised to see that the hardening was much slower, although the degree of heat had been about the proper degree, as was easy to perceive by the color. Examining

the construction of the two furnaces, I remarked that the bricks were burnt by being placed above the lime; that above the bricks tiles were placed, and, lastly, above all, pieces of burnt clay covered with fragments in such a way as to leave openings only in certain places, thereby directing currents of air into certain parts only of the kiln. It resulted from this arrangement, made with a view to save as much heat as possible, that only certain bricks and tiles were exposed, during calcination, to a current of air. I will remark, that the dust of these bricks always caused the mortars to harden more promptly than the others. On the other hand, I noticed that the hearth of the alum furnace was pierced with many holes, which caused a strong current of air throughout all the mass of clay submitted to calcination. Pl. I, Fig. 2, gives a plan and section of this furnace. The calcination is effected by wood placed in the lower arches. It then occurred to me that the reason why I obtained good results with this clay, and especially a rapid induration, might be, that at a high temperature the hydrate of alumine might absorb oxygen. I was led to this supposition because I had ascertained, page 318, vol. xx, that the hydrate of lime absorbed oxygen. I calcined a little clay in a current of air, and also a little in a close vessel, and I ascertained that the alumine that had been calcined in a current of air dissolved in sulphuric acid more easily than the other. This was a presumption for my hypothesis, but no proof. I had, likewise, heated in these two ways, a little alumine extracted from alum, and had made mortars by mixing it with lime from white marble. The mortar made of alumine burned in a current of air appeared to me to take consistence sooner than the other; but, after some time, both were equally soft, and at the end of a year had no consistence. This experiment seems to prove that alumine alone will not form puzzalona, and that it requires to be mixed with a certain quantity of silex; this result is besides in accordance with table No. XXII, in which we see that by taking away from clay too much sand, the energy of the cement was diminished, and that it was augmented on adding very fine siliceous sand. The alumine which I used having already been calcined and dissolved in sulphuric acid, to form alum, it is possible that this had taken from it the property of forming puzzalona, and the experiment should have been made with natural alumine; but this substance is very rare, and I had none at command. After these first essays, I made the last four experiments of table No. XX. We have seen that the hardening was very prompt; which was owing, as I said in speaking of those experiments, to the bricks being exposed to a current of air during the calcination. The bad mortar—the cement having been properly burned, gave a good resistance, and at the same time a very prompt induration. I then made the following experiments: I took Holsheim clay, of which I made two bricks; one of these bricks was of the natural clay, the other was of the natural clay mixed with 0.02 of lime in paste. I calcined these two bricks in a lime kiln, placing them where, as it seemed to me, they would be but little exposed to the current of air. I, at the same time, made balls of the size of a nut, of the same Holsheim clay, both in its natural state, and also mixed with 0.02 of lime, and afterward calcined these two kinds of balls in a reverberatory furnace, keeping them red during six hours, in a hessian crucible having a hole in the bottom. These last clays were, therefore, calcined in a current of air, and the former, not. The following results were obtained. The mortar of the natural clay heated in the lime kiln did not harden till the end of thirty days, and supported a weight of 385 lbs. before breaking; that which was made of the

same clay mixed with 0.02 of lime, hardened in seventeen days, and broke under a weight of 352 lbs. The mortar made of the natural clay that had been heated for six hours in a current of air, hardened in five days; but it broke under a weight of 330 lbs. Lastly, the mortar made of the clay which contained 0.02 of lime, and which was, also, heated for the same time in a current of air, hardened in three days; but this mortar was cracked, and broke under a weight of 198 lbs. These experiments were made in the beginning of 1825.

Having communicated these results to Mr. Bergère, *chef de bataillon*, of the engineers, he informed me that Mr. Raucourt, engineer of roads and bridges, had published at Petersburg, in 1822, a memoir in which he mentioned the influence of air on the calcination of clays that are to be transformed into puzzalonas. I procured this work, and quote the following remarks from page 130. "I had thought for a long time that the degree of calcination could not be the only cause of the superior qualities that argillaceous earths acquire by a few minutes' torrefaction: if it were otherwise, slightly burned bricks would furnish excellent puzzalonas, which is far from being the case, and several essays made with pounded bricks, burnt with various degrees of intensity, gave me no result comparable to that given by clay exposed on a red hot plate.

"It was thence inferred that the contact of air is necessary to modify, in the most favorable manner, the oxides which the earths contain, so that they may form good hydraulic combinations with lime. To assure myself more completely, I made direct experiments which fully confirmed this induction, and which led me to more particular researches than had before been made on factitious hydraulic lime."

The experiments of table No. XVI show, in opposition to the opinion of Mr. Raucourt, that lightly burned bricks may furnish very good puzzalonas, when they contain lime, and the burning has been properly managed. This engineer asserts positively, in this quotation, the necessity of contact of air to modify the clays advantageously; but he reports none of the experiments that he announces as having made.

At page 135 of his memoir he says:

"If it be true, as is said, that the earths are metallic oxides, one might be led to think that they have need of a certain degree of burning in contact with the air, to form with lime, and the concurrence of water, insoluble compounds; and as several chemists have already shown that the presence of silex in the state of gelly will contribute to render a fat lime hydraulic, that it is the same with the oxides of iron and magnesia; that Mr. Vicat, by his transformations with clay, proves that alumine, also, might enjoy this property; that if the very hydraulic lime I H (Art. 163) be observed, it will be allowed that magnesia must necessarily fulfil analogous functions; one would be almost convinced that all the metallic oxides, properly prepared with fire, would form, with lime, combinations susceptible of hardening in water."

There are many errors in this passage; for it is demonstrated that iron and manganese act no part in hydraulic limes; and what Mr. Raucourt says in this particular, proves that he has not consulted experience. Nothing has proved, as yet, that alumine, or magnesia, possesses the property of forming hydraulic lime. (The lime cited art. 163, contains clay.) Lastly, nothing is more doubtful than such properties as Mr. Raucourt has attributed to almost all metallic oxides. In a matter so delicate as this, the imagination must not get in advance of facts.

As Mr. Raucourt has not given the experiments which led him to the opinion that the air acts an important part in perfecting artificial puzzalomas, I am obliged to draw my conclusions from the facts presented in my preceding table, and principally from the last four experiments reported in page 24. There are two things to consider in artificial puzzalona; the first, is the promptitude of induration of the mortars whereof they form part; the second, is the resistance of these mortars. The experiments at the end of table No. XX, the observations I made on Nos. 5 and 6, of table No. XXIV, and the few experiments cited in page 24, prove that when these clays are calcined in a current of air, they harden much the more promptly. But is the resistance of the mortars greater, also? I cannot affirm positively that it is.

We see, for example, in the four experiments cited, that the case of the most prompt hardening, coincides with the weakest resistance; but we ought not to conclude from thence, in a positive manner, that the calcination in a current of air diminishes the resistance at the same time that it increases the promptitude to harden; because the result obtained may have depended on some other cause—as, for instance, the degree of calcination. What induces me to think that calcination of clays in a current of air, far from diminishing the resistance of mortars, will, on the contrary, augment it, is, that all the clays Nos. 5 and 6, of table No. XXIV, having been heated in this manner, the hardening was very prompt, at the same time that the resistances were very great. I cannot positively affirm that this last effect will follow, but I think it probable. I have not had time to make the direct experiments that I intended, in order to clear up this point.

In a note printed by me in 1825, I stated that I was induced to think that at an elevated temperature, the alumine contained in clays absorbed oxygen, and that this absorption rendered cements more proper to combine with fat lime in the moist way. Mr. Vicat is of a different opinion. He inserted a note in the *Annales de Chimie*, of 1827, Vol. XXXIV, wherein he says that he calcined, for half an hour, pulverised clay in close vessels, and that he heated the same quantity, during five minutes, on a metallic plate kept at a common red heat. After cooling, the substances were weighed, and were found to weigh nearly the same. Mr. Vicat concludes from the small differences found between the weights of clays calcined in close vessels, and those calcined in the air, that there is, incontestably, no absorption.

I will remark, that nothing can be concluded from this experiment. A part of the clay was calcined during half an hour, and the other part during five minutes only; the quantities of water lost by these two portions could not, therefore, have been the same, since they were not equally heated. It is, besides, possible that a small quantity of oxygen, difficult to appreciate with a balance, might suffice to give new properties to the clay. To know whether alumine absorbs oxygen, it would be necessary to heat it highly in a tube not susceptible of oxidation, and to pass, during the calcination, at different times, a given volume of oxygen gas, over the incandescent alumine, and, afterward, to measure the volume of gas, in order to ascertain whether it had been diminished. I had not under my control the means necessary for making this experiment; the observation that I made, that alumine calcined in a current of air, dissolved more easily in sulphuric acid than when calcined in a close vessel, led me to think there was an absorption of oxygen, but it is no proof; I offer it as a presumption only.

Several Engineers have proclaimed the good results obtained with ashes

derived from the combustion of coal in furnaces, or lime kilns; others on the contrary, have denied the effect of this substance. With this question, it is the same, I am satisfied, as with the question whether dust of tiles or bricks, much, or little burned, should be taken. The good results of the Tournay ashes* have been known for a long time, and are contested by no one. Having been employed at Lille, in 1815 and 1816, I had an opportunity of knowing the good effects. But when I wished to use, in the same way, the coal ashes at Strasburg, I could not obtain a good result. I made mortars composed of one part of fat lime measured in paste, and two parts of coal ashes: after an immersion of a year, these mortars were as soft as if made of sand. These opposite effects surprised me, and on examining different coals and their analyses, I saw that several of them contained quite a quantity of clay, while others contained little or none. But coals are generally burned on a grate: the clay they contain is thus calcined in a current of air; and it is the mixture of this clay with a little iron, constituting the residue, that is used, when we take these ashes: we see, therefore, that it is a real puzzalona that they have been making, for a long time, without knowing it. Should the coal contain no clay, or should the clay be mixed with too much lime; in the first case no result will be got; and in the second, if the calcination has been too high, the ashes will possess but an indifferent quality.

I think Mr. Sganzin is wrong when he says in his *cours de construction*, page 32, "Experience teaches that the ashes of all coals which have served for the calcination of lime, will form a mortar hardening promptly in water." We know that when lime is calcined with coal, the ashes of the combustible is mixed with a considerable quantity of particles of lime. Although the coal should contain no clay, if the lime calcined be very hydraulic, I conceive that a mortar of fat lime and these ashes would harden in water; but the result would be due to the presence of the hydraulic lime; I think that no result would be obtained if, with such coal, the calcination were of fat lime.

In 1826, I was charged with the inspection of several places along the Straits of Calais. Much coal is used in these departments. At Boulogne where the forts of the sea coast were to be repaired, I requested Capt. Le Marchand of the Engineers, to make some experiments with cements and the coal ashes of the neighbourhood, because the use of the Boulogne pebbles, before mentioned, was very expensive, and it was difficult to obtain them in quantity. This Engineer took great pains in his researches, and informed me that he had obtained good results with some cements, and especially with the ashes got from the coal burned in several manufactures in Boulogne. He procured the analysis of this coal, which is composed of the following substances; combustible matter, 96.62; alumine, 2.00; silex and iron, 1.38. Therefore the ashes he used were nothing else than a very aluminous clay, which contained no lime, and which had been calcined in a current of air during the combustion of the coal, and it is not astonishing that it gave very good mortar. The cinders of forges, another residue of the combustion of coal, may be assimilated to ashes: there are some that give very good, and others that yield no results: neither should, in any case,

*Rondelet, in his *art de batie* thus describes this substance. "This powder is made of half burned fragments of a very hard blue lime-stone. These fragments fall, during the burning, through the grate of the lime kilns, and are mixed with the ashes of the coal. The Tournay ashes are considered equal to the Dutch trass, and are used for the same purposes." Tr.

be employed without our being assured of their quality. To know if they may be used with advantage, the practical process for distinguishing good cements from those that have no hydraulic property, that I will soon point out, should be followed.

I commenced my experiments on artificial puzzalonas in 1821; and the first operation I performed was to see whether I could make puzzalona and trass anew out of their constituents. I accordingly took the substances contained in trass and puzzalona, according to the old analysis which is given in Vol. XX, p. 391; with these I made a paste with water; afterward, I calcined the mixture at a low red heat for six hours; and, lastly, reduced it to very fine powder. As I had no natural alumine at my command, and as I doubted the efficacy of that to be obtained from the decomposition of alum, I took the Cologne pipe clay, washed it several times with a great deal of water, and decanted, to separate the greater part of the sand from the alumine. I assured myself, by calcining a small portion of this earth, and dissolving it in sulphuric acid, that it contained hardly any silex. This is the substance to which I added the other matters in the proportions given in the old analysis. We see then that, by this operation, my artificial trass and puzzalona had a little more silex than the natural productions, by the quantity retained in the aluminous earth; but this augmentation of silex was the same for both mixtures. I made two mortars by taking one part of Obernai lime, and two parts of each of these compounds: the mortar of the factitious trass hardened in four days, and broke under the weight of 385 lbs: that made of the artificial puzzalona hardened in three days and supported 477 lbs. before breaking. The lime was the same in both experiments: all other circumstances were alike: wherefore we must attribute the superiority of the artificial puzzalona over the artificial trass, to the clay of the first mixture containing much more alumine than the second. I was wrong in using hydraulic lime: I should have used fat lime, which I, afterward, always used when I wished to determine the quality of puzzalonas or other analagous substances. This experiment, and those which were made of the very aluminous clays of Frankfort and Cologne, prove that results, exactly like those furnished by natural puzzalona, are obtained, by suitably calcining greasy clays.

I was not able to determine the proportion in which the silex and alumine should exist to give the best results; but I am led to think that the alumine should equal, at least, a third of the silex. We have seen, however, that the Sufflenheim clay, which contains seven parts of silex to one of alumine, sometimes produced very good cements; but it is probable the best were obtained with portions of clays more aluminous than the others. The results contained in table No. XXII support this opinion. It is true we might be inclined to infer the contrary from the new analysis of trass and puzzalona made by Mr. Berthier, and given in Vol. XX, p. 391. The proportion of alumine is about the same in Trass and Puzzalona, according to Mr. Berthier, and is much smaller than according to the older analysis: but the analysis of a single specimen must not fix the proportions of a substance which gives, as we have seen, very various results; and every thing leads to the belief that the several pieces of trass and puzzalona vary much in their composition. It is possible that the specimens of trass and puzzalona that I sent to Mr. Berthier, were possessed of a high degree of energy, although containing but little alumine, by reason of the potash they contained; for this substance augments, in a sensible manner, the energy of puzzalonas, as we have seen in the experiments of table No. XXIII. But

the good results obtained from the calcination of greasy clays, prove that cements without potash, may be made to be quite equal to trass and puzzalona.

The experiments above show that, with artificial puzzalona and fat lime I have obtained mortars much superior to those made with artificial, or even natural, hydraulic lime, and sand. Although I happened, with some pieces of Obernai lime, to obtain results approaching those afforded by artificial puzzalona, such instances are rare; and, in cases like these, it is the general bearing of the facts that we are to regard. I announced these results in a little pamphlet published in 1824, and I stated, moreover, that there would accrue a sensible economy. Mr. Vicat, in a criticism on this pamphlet has endeavoured to prove the contrary; but it will not be difficult to show that he was deceived in his calculations. This Engineer says "The objection of Mr. Treussart to the high price of artificial limes is without foundation. In fact the trass mortars are as follows:

For two cubic metres of trass (70.68 cub. feet) *a* $5.22½ .	$10.45
For one cub. metre (35.34 cub. ft.) of fat lime in paste . .	2.28
	$12..73

"The three cubic metres of materials are reduced by the mixture to 2.30m; it follows that the cubic metre costs $5.53 (35.34 cub. ft. cost $5.53 equal $0.16 per cub. foot.)

On the other hand to make a cubic metre of hydraulic lime mortar, requires 0.90m of common sand *a* $0.28½	$0.26
0.43m of hydraulic lime in stiff paste, which at the mean price will cost (one foot cost $0.34) . .	5.27
	$5.53

The prices then will be exactly the same, since in each case it is found to be $5.53: but let us see if the basis of this calculation is exact. I will first remark, what I did not neglect to state in my pamphlet of 1824, namely that the mortars of fat lime, sand and trass, gave me results which were often superior to those in which there was trass without sand; and that it was the same with mortars made of puzzalona. We may satisfy ourselves by table No. XIII that when the mortars of trass and puzzalona, alone, were superior to those containing sand, the advantage was not sufficient to lead to a preference of the former. I obtained a like result with artificial puzzalona of table No. XXIV. It is, therefore, an error of Mr. Vicat's to compare the price of mortars made of artificial hydraulic lime, with that made of fat lime and trass without sand: it is necessary to compare it with mortar made of lime, sand and trass. If the first calculation, above, be thus rectified, the price of $10.45, given by two cubic metres of trass at $5.22½, will be reduced to $5.51, resulting from one cub. metre of sand at $0.28½, and one cub. metre of trass at $5.22½: consequently the cubic metre of mortar composed of fat lime, sand and trass, will amount to $3.39=$0.10 per cub. foot, only, instead of $5.53. The objection that I made, therefore, is not, as Mr. Vicat thought, without foundation. I feel bound to state that the prices I have given, using the data established by Mr. Vicat, appear to me to be too low for the principal places in France; but I was obliged to use the elements he had employed.

It is possible that in countries where chalk is abundant it will not cost more to make hydraulic mortar with artificial hydraulic lime and sand,

than with fat lime, sand and factitious trass: but in many countries chalk is not to be procured; and then it will be necessary to mix fat lime with clay, and to give a second burning for the mixtures; which will cause embarrassment, and an augmentation of expense. I am convinced that, in such cases, there will generally be economy in making hydraulic mortar at once of fat lime, sand and artificial trass: and besides the relation of the resistance of these two kinds of mortar, is no important consideration. If we compare the results obtained in all the preceding tables, we shall see that the mortars made of sand and hydraulic lime, whether natural or artificial, afford an average resistance hardly amounting to 220 lbs., while it is 352 lbs. for the mortars made of fat lime, sand and natural or artificial trass. To compare the expense justly, therefore, it would be necessary to lessen the preparation of trass, substituting sand, until we arrived at an equal resistance.

I must, besides, observe that we are much more certain to obtain uniform results with hydraulic mortars, composed of fat lime, sand and factitious trass, than with those that can be made of artificial, or natural hydraulic lime, and sand only. We have seen, in fact, that hydraulic limes deteriorate when a little too highly calcined; it is necessary to keep them carefully from the rain; and they, in general, lose a great part of their hydraulic property, unless used soon after leaving the kiln; which often occasions embarrassment. With fat lime and factitious trass, all these difficulties are avoided; because the lime loses nothing by being a little more calcined than necessary. It is not necessary to use it immediately, nor to take any troublesome precautions. As to factitious trass, once prepared, it needs no particular care: for neither the influence of the air, nor humidity, will deprive it of any of its properties.

It results from what I have said that, in a country where there are good natural hydraulic limes, they should be used in preference to fat lime, which requires, always, to be mixed with natural or artificial trass, for constructions in water or in damp places. There will be economy, and no bad results to fear, in taking the precautions I have pointed out. When, however, works demanding great care, are to be made, such as floors of Locks, caps of Arches, &c., I think it will be proper to add to the mortar a little natural or artificial trass. The proportion to be added depends on the quality of the hydraulic lime and of the trass. If both are of good quality, and if it be known, for example, that the lime will bear two and a half parts of sand, then the mortar may be composed of one part of this lime, two parts of sand, and half a part of factitious trass. This small quantity of trass will not much augment the expense, and will always correct the bad effects resulting from portions of the lime having been too much burned, or impaired by exposure to the air. The further the hydraulic limes are from the qualities I have above supposed, the greater should be the proportions of natural or artificial trass.

The question, however, is, to know what should be done in a country where there is no hydraulic lime, or where it is of an inferior quality. It is on this point that I differ entirely from Mr. Vicat. This engineer contends that it is best to make factitious hydraulic cement by the process he points out; while I think there will, in general, be more economy, and better and more uniform results, by making hydraulic mortars at once from fat lime, sand, and artificial trass. It appears to me that the general bearing of the very numerous experiments I have presented, leaves no room to doubt as to this matter.

I will add, that, from time immemorial, in countries affording natural hy-

draulic limes, they have been used with great advantage. Wherever they were not to be had, hydraulic mortars were made, directly, of fat lime and cement. I have, several times, had occasion to demolish works in water, of which the mortars had been made in this manner. It appears then, that, in fact, I only propose to continue a method long in use, with this difference, that in lieu of using every kind of cement indiscriminately, I give the means of distinguishing the good from the bad, and of making such as will give results equal to those furnished by natural puzzalona or trass.

To ascertain which are proper cements to produce good hydraulic mortars, on being mixed with fat lime, the following means may be used. From a neighbouring brick kiln three bricks should be taken, one of which should be a lightly burned brick; another should be chosen from those which are considered to be burned in the best manner; and a third from those too much burned, but not vitrified in any degree. The brickmakers know well how to distinguish them by the sound and the colour. A fragment of each of these bricks should be separately reduced to a very fine powder, and passed through a very fine wire seive. The finer the dust, the better; in taking it between the fingers no grains should be felt, and it should be soft to the touch. Fat lime which has been reduced to paste for some time, should then be made into mortar with one of these cements—using one part of lime in paste, to two parts of cement. They must be well mixed together, adding the water, necessary to produce a pasty state. The mortar should then be placed in the bottom of a tumbler. If the mortar be stiff, the tumbler may at once be filled with water; if, on the other hand, the mortar has been made rather thin (which facilitates the mixing) it should he left long enough in the air to assume some consistence before the glass be filled. The same course should be followed with the two other cements, and all the glasses must be ticketed. It is necessary to add, in making the several mortars, such quantities of water as will bring all to the same consistence, nearly. After two or three days, the mortars should be touched lightly with the fingers, to ascertain whether they have begun to harden; and when this happens, they must be examined every day, noting that which hardens first, and the time at which each arrived at that degree of induration that on pressing it strongly with the thumb no impression was made. In order to judge more accurately of this state, the turbid water must be thrown off, and the surface of the mortar, which is always covered with a little semi-fluid matter, must be lightly cleaned with a rag. If the mortar is not yet hard enough to resist the thumb when strongly pressed, it must be again covered with water for subsequent examination. Should there be several brick yards at hand, using different clays, the same process should be applied to the brick dust from each. It will be useless to try dust from tiles, provided the clay is the same as that used for bricks, because the result would be substantially the same.

We have seen that the dust of bricks which have been burned in a current of air, hardened in the space of three or four days, while the dust of bricks burned out of a current of air, has generally taken from ten to twenty days, and sometimes even thirty days to harden, and has, nevertheless, made good mortars. I have also made the remark, that mortars of the hydraulic limes which harden very quickly, did not give great resistances; but those made of cements which have caused fat lime to harden promptly, have always given good mortars. We ought, therefore, to prefer those cements which cause fat lime to harden promptly. If any cement, after fifteen or

twenty days, gives to fat lime only a weak consistence, it should not be employed.

In experimenting with the ashes and cinders of forges, the same process should be followed. If, of these substances, after a month's immersion, any should impart to fat lime but a feeble consistence, or remain entirely soft—in neither case should it be employed.

By means of a very simple chemical process, it may be ascertained before hand, whether bricks but little, or highly, burned, should be taken. Take a little of the crude clay, or a little of the brick dust, put it in a glass and pour over it a little diluted nitric or muriatic acid, or even strong vinegar; should there be no effervescence, it is proof that the bricks should be highly calcined to give good cement. Should there be considerable effervescence, it is because the clay contains a notable quantity of carbonate of lime. To determine nearly the quantity of lime, a little of the clay, having been dried in a gentle heat, must be weighed; it must then be diffused through a small quantity of water, and muriatic acid be poured on, little by little, as long as there is any effervescence; it should then be filtered, or gently decanted, the residue washed in a large quantity of water and again decanted. The residue being then dried in the same gentle heat as at first, must be again weighed; if the weight be less by one tenth, than at first, it is a proof that the clay contained that quantity, about, of carbonate of lime, which has been dissolved out by the acid. In this case bricks but lightly burned must be taken; and so much the less burned as the loss of the clay, by the acid, shall have been the greater. If the clay lose only four or five per cent. of its weight, the bricks which are called "well burned bricks," should be preferred. In addition to the chemical trial just described, it will always be proper to make the trial first explained—that being the most certain.

With brick dust, we may easily obtain mortars which, according to my mode of determining tenacity, will support from 220 lbs. to 330 lbs. before breaking, if composed of equal parts of lime, sand and brick dust. This force is sufficient for gross masonry: but, for important works, such as the floors of locks, foundations of dikes and dams, caps of arches, and for factitious stones, of which I shall speak in the sequel, it is necessary to have cements that will give mortars capable of supporting from 330 lbs. to 440 lbs.

To obtain cements or puzzalonas of the strength just mentioned, we proceed in the following manner. We choose clays soft to the touch, taking, in preference, those of which earthen ware, stone ware, delft ware and tobacco pipes are made, ascertaining, by the above chemical trials, whether there be any lime, and if so, the quantity. Of these clays we make balls of the size of an egg, which we calcine in a reverberatory furnace, heating gently at first, and, after about one hour, pushing the fire so as to keep the balls constantly at a low red heat; the balls, of which there will be ten or twelve, being placed within a large Hessian crucible having a hole in its bottom. To avoid exposing these clays to be struck by a current of cold air, as they would be if put on the bottom of the crucible, a piece of slate perforated with many small holes should be put across the middle of the crucible, (which is commonly of a conical form, narrowest at the bottom:) by this means the balls of clay will be in the centre of heat, and will be, during the calcination, always in contact with a current of atmospheric air. When the balls have been burned for three or four hours, according to the quantity of lime contained in them, one of these balls will be taken out, and

marked with the number of hours it has been under calcination; at the end of every succeeding hour another ball will be withdrawn and marked in like manner. All the balls being withdrawn, they will be reduced to fine powder, and a mortar will be made of each, exactly in the same way as was pointed out for mortars made of brick dust. We shall ascertain, in this way, the time of burning required by the clay, to give to fat lime the most prompt induration, and we shall have an idea of the difficulty to be overcome in reducing the cement to powder. To operate on a large scale proceed as follows.

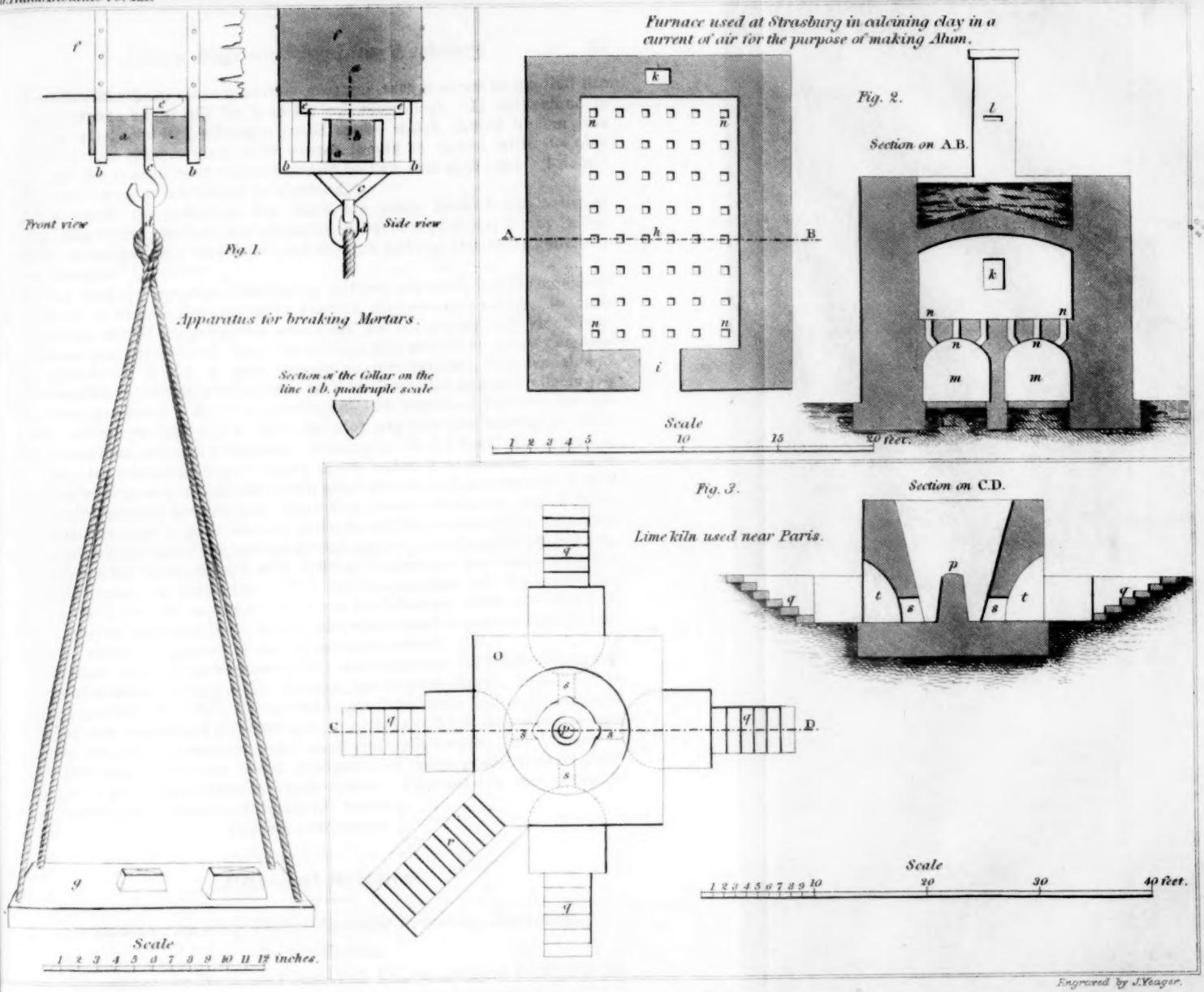
In countries where wood only is to be burned, a furnace may be made like that in the plate I, Fig. 2. If the clay to be used be greasy, the expense of tempering it may be saved. It will be cut from the bank into pieces, of the form and dimensions of common bricks. These will be dried in the air like bricks, and then be placed on their edges on the hearth of the furnace, laying them obliquely with respect to its axis, and at a little distance asunder; the second layer will be placed on the first, crossing them. A fire will then be made in the two arches below the hearth, gentle at first, and gradually increased. It is apparent that the clay will, in this way, be calcined in a current of air, through the holes in the hearth. These bricks will be heated less intensely than the balls that were in the reverberatory furnace, and it will therefore be requisite to leave them exposed to the fire for a longer period. After twelve or eighteen hours calcination, one brick will be withdrawn. If the clay is coloured with iron, the colour will now be compared with the colour of that specimen of the first trial which gave the most prompt induration to fat lime. If the colours are exactly alike, it is a proof that the clays in the furnace have received sufficient calcination, and the fire will be stopped; but if the colours are different, the heat will be continued, and another comparison will be made, after another lapse of time; and so on until a colour is obtained which indicates the proper degree of burning.

If the clay contain little or no iron, or if the furnace trial showed that the colour varied but little with considerable variations in the intensity of heat, then, having withdrawn, successively, several bricks, reduce them to fine powder, and make several mortars by mixing this powder with fat lime —noting the time required to harden, and taking all the precautions directed for the proof essay. In the first batches burned on a large scale, considerable pains will undoubtedly be required to determine the time requisite for the best degree of calcination; but when this point is once ascertained, there will be no longer any difficulty, and the operation may be confided to ordinary workmen.

In countries where the fuel must be coal or peat, it will be preferable to use a conical kiln for burning the clay. I will observe here, that Mr. Chaptal in calcining the clays of the south, in a conical kiln, placed them, by accident it appears, in the most advantageous position; that is to say, they were so placed as to cause them to be calcined in a current of atmospheric air. If this celebrated chemist had noticed the great action that lime exercises on the calcination of clays; and that it is necessary to heat but little when the clay contains as much as one tenth, and to heat much when it contains little or no lime; he would have completely resolved the important question of the perfection of artificial puzzalonas. In many of the northern Departments, conical furnaces are used for burning lime. Plate I, Fig. 3, represents one of those furnaces which I saw in the neighborhood of Paris. The following is the mode to be adapted in burning clays therein. Instead of

the form of bricks, the clay will be cut from the bank with a shovel, into nearly cubical pieces. A workman will then with his hands, flatten the angles, giving to each piece a rounded form of the size of an apple, which will not require much labour. These balls will be left to dry in the air. Preparatory to placing the balls in the kiln, an arch of dry stone masonry, will be turned from the centre pier to the sides of the kiln, at the height of the top of the four doors. The centre pier serves, besides, to direct the contents of the kiln towards the doors. The dry stone arch will be so constructed as to leave passages for the air. A rather thick layer of coal or turf will be put upon the arch, and on this a layer of balls of clay, thus filling the kiln with successive layers of fuel and balls of clay. When the kiln is two-thirds full, the arches will be filled with fuel. The fire being lighted at the four openings, will gain the whole interior of the kiln, and the clays will be thus calcined in a current of air. After some time—demolishing a portion of the dry stone arch, a few balls of clay will be withdrawn, with which the different essays that I have pointed out, in speaking of the other furnace, will be made. The dry stone arch will permit the fuel to be renewed under the clay, until the balls of clay near the bottom, and which are the least burned, have received the requisite calcination. In proportion as the combustible is consumed, the mass of balls of clay will subside, and new layers of balls and of fuel will be supplied above. When the trials have shown the clay below to be sufficiently burned, the arch will be taken out. The lower balls will fall towards the openings, and will be removed with tongs. The others will descend, also, as the fuel burns away. As fast as clay is withdrawn from below, fuel and clay will be added above, so as to make the burning continual. If some balls are found not sufficiently burned, they will be put aside, and when enough are collected, will be reburned by being mixed with less fuel. A kiln built expressly for making puzzalona, might be of smaller dimensions than that represented in Fig. 3. Perhaps two openings would suffice; replacing in this case the pier in the middle by a wall of the same height, sloping both ways, and presenting an arch towards each of the openings.* This kind of kiln would be of great advantage in the calcination of hydraulic lime, as it would supply fresh quick lime during all the season of operation—an important object, as we have seen by preceding experiments. There would also be a more uniform burning than in the kilns ordinarily constructed in Alsace, where the lime is burned in a very unequal manner. I am persuaded that in places where coal can be procured at a moderate price, great advantages may be derived from conical furnaces; which will serve, at the same time, for the calcination of hydraulic lime, and of clays of which it is designed to make artificial puzzalona.

* In situations where calcined clay is hard to pulverize, and there is no machinery to apply to this object, the crude clay should be dried in the air, and being reduced to powder, should be burned in a reverberatory furnace of which the hearth is laid at the greatest angle that the clay dust will lie without sliding. On this inclined hearth a layer of dry powder will be placed of the thickness of six to eight inches. The front of the furnace should have a horizontal portion, on which to make a fire of wood. The inclination of the hearth will cause the heat and flame in passing upward towards a chimney in the part opposite to the fire, to heat the powdered clay. From time to time, the heat will be suspended in order to stir the clay with a rake. In this way it will be calcined in a current of air, and the operation of pulverising the cement, which is both tedious and expensive, when there is at command no proper machinery worked by water, will be avoided. Au.


Front view
Side view
Fig. 1.
Apparatus for breaking Mortars.
Section of the Collar on the line a b. quadruple scale
Scale
1 2 3 4 5 6 7 8 9 10 11 12 inches.
Furnace used at Strasburg in calcining clay in a current of air for the purpose of making Alum.
Fig. 2.
Section on A.B.
Scale
1 2 3 4 5 10 15 20 feet.
Fig. 3.
Lime kiln used near Paris.
Section on C.D.
Scale
1 2 3 4 5 6 7 8 9 10 20 30 40 feet.
Engraved by J. Yeager.

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In countries where there is neither coal nor turf, it seems to me that the conical furnace might still be used for calcining clays. It will suffice to take dry wood, and in preference round sticks, which should be cut into lengths of four inches: these little pieces should be mixed with the clay balls, and the operation of burning should be like that with coal. I do not doubt that a good result would be obtained.

Clays which are greasy to the touch are easily formed into balls, or shaped like bricks, without any preparation; but it is possible, it may be necessary to temper such clay as is used in brick making, this being generally more meagre.

When very greasy clays, containing no lime, are used, it will sometimes be difficult to reduce the cement to powder without machinery. In such cases, clays should be preferred which are not too greasy and which contain about five per cent. of lime: these clays are, moreover, more common than others. It is not to give energy to the cements that we should prefer earths containing a little lime: we have seen that opposite effects are sometimes produced. But the presence of this substance has two considerable advantages; the first is that the clay requires less burning to yield good puzzalona, whence results an economy as to the fuel: the second is that the clay containing lime is more easily reduced to powder. Thus it might be well to mix a little lime with clays which contain none, or to mix clays which contain no lime with clays that contain too much: but as these operations require a good deal of work, it will be necessary to calculate the relative expense of the several modes, namely, burning the clays hard, and pulverizing them, though with difficulty—mixing a little lime with the clay—or mixing clays together. The relative expense will depend on the price of fuel, and the means at command for breaking down the clay. A pestle mill, or mill with large stones, like those used in pulverizing plaster of Paris, would, it appears to me, be most convenient.

The name *puzzalona* expresses that this substance is obtained from the village of Pouzzol in Italy—that of *trass*, has no etymology. In the notice which I published in 1825, I proposed to give the name hydraulic cements to substances substituted for trass and puzzalona. This denomination appears to me to be convenient, and I shall generally employ it. I have entered into many details as to the fabrication of these productions because they are of great importance in constructions. I proceed to report sundry experiments that I made with hydraulic mortars.

[TO BE CONTINUED.]

Physical Science.

Speculations respecting Electro Magnetic Propelling Machinery.

BY THE EDITOR.

In our number for November last, Vol. XX, p. 340, we published the specification of Mr. Davenport's patent for a machine intended to furnish a motive power by the agency of Electro Magnetism, to which we appended some remarks upon the subject generally. We had hoped, ere now, to have received more definitive information than has transpired, respecting the progress of the experiments which are being made in New York with a view to its testing the utility by applying it to drive a Napier Press, requiring a two horse power; we have hitherto learnt nothing of the result,

of this proposed experiment; and suppose, therefore, that the trial has not yet been made.

Since publishing the article above alluded to, it has appeared to us that should a much less power be attained by such a machine than that which is now sought for, say the power of a man only, it would still be equally valuable with the steam engine, and would produce as great, if not a greater change, in the economy of the useful arts, as has been produced by that instrument; this, however, is under the proviso that the cost of materials consumed in performing the work of a day should be less than that given for the labour of a man. Who is there who would not under such circumstances, need such a machine? If we hire a man by the day we must not allow him to be idle, as in that case we give our money for nothing. The current of his life flows on, and he must be fed and clothed or the stream will stop. But give us a machine which is not costly at first, and which if it works but one hour in the twenty-four, will itself be a consumer in that proportion only; a machine which we can at any moment set to turn our lathes, our grindstones, our washing machines, our churns, our circular saws, and a catalogue of other things which it would be no easy task to make out; such a machine would also perform a million of other operations by the conversion of the rotary into a reciprocating motion; and we again ask who is there among us who would not want one? our farmers, our mechanics, and our housekeepers generally, must all be supplied. We could no more submit to live without it, after it has been once introduced, than we can now submit to travel at the slow rate of ten miles an hour, an event which we have learnt to think one of the miseries of human life.

With such a machine at our command we should soon wonder how we could have lived so long without it; and if taken from us it would leave a most awful chasm in the necessaries of life, of the existence of which our fathers never dreamed, and which happily we could not be called upon to witness so long as the store house of nature would enable us to obtain zinc and sulphuric acid at a cheap rate.

The steam engine cannot be used to advantage where it has not the labour of several horses to perform, as, whether large or small, it requires the constant attention of the engineer, or of the fireman, and is kept at work at an expense which is relatively increased as its power is diminished. One giving the power of a man only would be employed, at a cost which would pay the hire of two or three men, and if used but for an hour or two in the day, the expense would be incalculably increased; of course it is not, and never will be used, under such circumstances.

Let it not be said that we are prophesying about what is to happen; not so by any means; but be it remembered that we are speaking of what is a possible contingency. We have no doubt respecting the practicability of obtaining the power of a man by the agency of electro magnetism; we believe that such a machine may be kept at work without any considerable tax upon the time of the person using it, and we further believe that the only thing which can prevent its coming into use is, the cost of the materials employed in operating it; the statements which we have heard upon this point are extremely contradictory, and upon the whole, are far from encouraging; the time, however, is not remote when this point will be determined.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Reduction of observations of the Solar Eclipse of July 26th and 27th, 1832.

By E. Otis Kendall.

This Eclipse was observed at several places in Europe and America, as follows:

No.	Place of observation.	Latitude.	Phase obs'vd.	Mean time of observation.	Observer.
				d h m s	
1	St. Croix.	+17° 44′ 32″	Begin.	26 19 11 52.80	Andrew Lang.
2			End.	21 34 16.30	
3	Phila. 0.12s. E. of	+39 56 59	Begin.	18 54 46.20	S. C. Walker.
4	State House.		End.	20 39 20.20	
5	Phila. 0.7s. W. of		Begin.	18 54 54.60	Wm. Mason.
6	State House.		End.	20 39 13.40	
7	Warminster Pa.	+40 8	End.	20 39 8.30	E. W. Bean.
8	Albany,	+42 39 3	Begin.	19 7 2.50	Prof. Alexander.
9			End.	20 45 45.50	Cerquero.
10	San Fernando,	+36 27 43.5	Begin.	27 1 3 31.50	Sanchez.
11			End.	3 9 4.75	Montojo.
12	Marseilles,	+43 17 50.1	Begin.	2 23 37.43	Gambart.
13			End.	3 35 35.21	
14	Padua,	+45 24 2	Begin.	3 11 33.70	Santini.
15			End.	3 47 10.80	
16	St. Helena,	−15 55 26	Begin.	2 33 44.00	Johnson.
17			End.	3 32 24.30	Armstrong.

It therefore furnishes a good opportunity for determining the longitudes of several places in this country by comparison with corresponding European Observations.

The Sun's and Moon's places in the Berlin Jahrbuch for that date, were used in computing the following Elements and Co-ordinates with the logarithms of their variation in a mean solar hour, according to the method of Bessel, (Ast. Nacht. No. 321.)

		log. Hourly Variation.		log. Hourly Variation.
T	1h 20m		2h 20m	
σ	9h 40m 43.64s		10h 40m 53.50s	
x	−0.893492		−0.315999	
y	+0.221782		+0.139504	
a	+126° 43′ 23″.23	+2.1534	+126° 45′ 45″.60	+2.1534
$l.\cos.d$	+9.975198	+5.3901	+9.975222	+5.3892
$l.\sin.d$	+9.516584	−6.3063	+9.516382	−6.3070
l	+0.530935	+5.8290	+0.530989	+5.6232
N	+ 98° 5′ 44″.77	+1.6658	+ 98° 7′ 23″.09	+1.7203
$l.\frac{s}{n}$	+3.790347	+5.6580	+3.790430	+5.5472
$l.h$	+0.225087		+0.225209	

		log. Hourly Variation.
T	3h 20m	
σ	11h 41m 3.35s	
x	+0.261358	
y	+0.056945	
a	+126° 48′ 7.95″	+2.1533
$l.$ cos. d	+9.975247	+5.3892
$l.$ sin. d	+9.516179	+6.3075
l	+0.531019	+5.1833
N	+ 98° 9′ 4.09″	+1.6810
$l.\frac{s}{n}$	+3.790502	+5.5916
$l.\ h$	+0.225324	

Using these Co-ordinates and Elements I have deduced, by Bessel's formulæ, in the paper above referred to, the following co-efficients of ε ζ and η,

No.	m −	a	b	c	d −
	h m s				h m s
1	−4 18 28.188	+1.679	−0.086	+1.681	−4 18 50.915
2	−4 18 27.047	+1.680	+0.453	−1.740	−4 18 38.740
3	−5 0 12.377	+1.679	+1.446	+2.215	−5 0 40.278
4	−5 0 27.144	+1.680	−0.970	−1.940	−5 0 35.085
5	−5 0 4.003	+1.679	+1.444	+2.215	−5 0 31.902
6	−5 0 32.185	+1.680	−0.971	−1.940	−5 0 40.125
7	−5 0 32.963	+1.680	−0.985	−1.947	−5 0 40.852
8	−4 54 21.852	+1.679	+1.675	+2.371	−4 54 50.797
9	−4 54 44.768	+1.680	−1.180	−2.053	−4 54 51.859
10	−0 24 27.767	+1.680	+0.832	+1.875	−0 24 53.144
11	−0 24 37.785	+1.680	−1.557	−2.291	−0 24 43.224
12	+0 22 5.752	+1.680	+2.044	+2.646	+0 21 33.040
13	+0 21 15.630	+1.680	−3.754	−4.113	+0 21 21.371
14	+0 48 19.213	+1.680	+3.848	+4.201	+0 47 39.111
15	+0 46 40.356	+1.680	−10.024	−10.164	+0 47 21.045
16	−0 21 44.566	+1.680	−7.827	+8.005	−0 22 13.294
17	−0 22 27.846	+1.681	−2.440	−2.962	−0 22 59.423

Where

m = the Longitude + East, — West from Greenwich which would result from these observations, if the places of the Sun and Moon as given in the Berlin Jahrbuch were free from error.

Making

ε = the correction of the tabular place of the Moon in its orbit, in seconds of space.

ζ = the number of seconds of space by which the Moon is farther north or south than its tabular place.

η = the correction of the sum of the tabular semi-diameters of the Sun and Moon in seconds of space.

d = the longitude from Greenwich resulting from the application of these corrections as far as determined, then by Bessel's formulæ,

$$(A) \ldots\ldots d = m + a\,\varepsilon + b\,\zeta + c\,\eta$$

From the above equations the most probable values of ζ and η have been determined by Gauss', method of least squares and are as follows, $\zeta = -2''.1350, \eta = -3''.5622$. With these values of ζ and η, and their co-efficients b and c above, the values of ε have been obtained by adopting for the longitudes of San-Fernando, Marseilles and Padua, those contained in the Nautical Almanac for 1838.

No.	Place.	Phase.	ε	Mean of Beginning and End.
10	San Fernando.	Beginning.	$-7''.668$	$-10''.617$
11		End.	$-13\ .567$	
12	Marseilles.	Beginning.	$-12\ .478$	$-\ 9\ .005$
13		End.	$-\ 5\ .532$	
14	Padua.	Beginning.	$-15\ .973$	$-10\ .596$
15		End.	$-\ 5\ .219$	
Mean of all the values of $\varepsilon = -10''.073$.				

Thus we have $\varepsilon = -10''.073$
$\zeta = -\ 2\ .135$
$\eta = -\ 3\ .562$

These values in the equations (A) furnish for d the results found in the third table, which are the most probable longitudes of the places of observation as derived from this eclipse. The longitudes deduced from the American observations are here repeated.

	h.	m.	s.
St. Croix, A. Lang's Observatory W. of Greenwich,	4	18	44.83
Phila. State House, by S. C. Walker's Observation W. of "	5	0	37.80
" " Wm. Mason's " " "	5	0	35.31
Warminster, Bucks county, Pa. by E. W. Bean's " "	5	0	40.85
Albany Academy, by Prof. Alexander's " " "	4	54	51.33

In making the above computations, the ellipticity of the earth was assumed to be 0.00324.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

Simultaneous Meteorological Observations. By John W. Draper, M. D. *Prof. of Chem. in Hampden Sydney College, Virginia.*

The importance of the subject of meteorology, is at last beginning to be understood and felt by the scientific world; and in many parts of the United States private individuals have commenced keeping journals for the express purpose of aiding for the development of the laws, regulating the atmospherical phenomena. These journals, however, insulatidly considered, are of but little service; it is only when they stand in comparison with other similar papers containing observations made simultaneously at distant points, that their true value becomes apparent.

The faculty of Hampden Sydney College, Virginia, considering how desirable it was to organize a corps of efficient observers throughout the State, in case any thing should be done by Congress to provide the means for making this kind of observations, resolved, that in addition to the usual college duties of the senior class, they would hereafter require of them to keep a meteorological journal, containing at least three observations each day, Sunday excepted, of the barometer, thermometer, wind, and general observations, and the dew point once at least. On the plan going into

operation, a number of individuals of the junior class volunteered their services; classes were arranged for each kind of observations and the general supervision given to the professor of Natural Philosophy.

It is highly desirable that similar arrangements should be made in every College in the United States. At Hampden Sydney the plan has been found to work without difficulty, and the hours of observation, having been judiciously arranged with reference to other College duties, the young men have little or no extra trouble. Colleges are the natural depositories of this kind of information—and as most of them, perhaps all, possess the requisite instruments, these operations can be conducted with extraordinary facilities;—Nor does the advantage end there, for an extensive class of able observers is gradually disseminated through the state.

I send herewith the result of the observations of the senior and junior classes, for the last month, to be disposed of as may appear best, and if published I hope it may draw the attention of other Colleges, in other States, to the subject. In this State, I have reason to believe it will be the cause of a systematic series of operations.

Meteorological Observations for Nov. 1837, *Hampden Sydney College, Va.*

	Therm.			Min.	Barom.			Annex'd Therm.	Dew point.	Wind.	General remarks.
7	56	65	61		29.64	29.49	29.58	64.84	40	SW. NW. N.	
8	36	52	54	34	29.90	29.95	29.95	56.62.62	46½	NW. NW. E.	
9	42	60	60	30	29.93	29.92	29.80	53.60.60	37	SW. W. W.	
10	56	62	60	52½	29.79	29.78	29.68	59.60.62	58	SW. SW. NE.	Rain till 12 o'clock.
11	50	56	56	41	29.66	29.63	29.53	58.61.62	57		Fog. all dny.
12											
13	50	52	48	41	29.37	29.40	29.37	63.63.61	51	NE, NE. NE.	Rained from 8. A. M. all day.
14	40		48	38	29.32	29.35	29.41	55 56.56	39	NW. NW. N.	Cloudy till 12.
15	35	56	48	25	29.61	29.64	29.65	51.53.54	42½	NW. SW. SW.	Aurora seen this evening.
16	30	50	50	24	29.75	29.83	29.84	47,53.53	37	W. N. NE.	
17	34	48	50	25	29.96	29.99	99.97	47.57.57	41½	SW. W. SW.	
18	38			32	29.88	29.84	29.77	50.56.58	43½	SW. SW. SW.	
19											
20	52	66	68	41	29.76	27.78	29.74	62.69	55	SW. SW. SW.	
21	48	66	67		29.66	29.63	29.53	70.67	55	SW. SW. SW.	
22	55	67	68	51	29.20	29.00	28-78	69.70.71	58	SW. SW. SW.	Storm from SW. P. M. commencing 4½. till 9 P. M.
23	30	35	36	28	28.97	29.03	29.04	55.51.54	19	NW. W. W.	
24	29	38	35	25	28.99	29.04	29.03	39.51.46	18	W. NW. W.	Cloudy.
25	23	32	23	19½	29.39	29.23	29.23	35.45.42	32½	SW. SW. W.	
26											
27	26	43	46	7	29.73	29.87	29.87	33,49.49	31	SE. SE. S.	
28	37	51	53	30	29.95	29.99	29.95	43.47.49	41	NW. W. W.	
29	43	60	63½	31	29.95	29.93	29.87	49.56.58	42	SW. SW. W.	
30	50	63	64	42	29.83	29.87	29.79	56.61.63	49	SW. SW. SW.	

We are gratified in receiving from our esteemed correspondent, the foregoing remarks and meteorological observations, so much in unison with the wishes heretofore expressed in this Journal. It is, however, more especially desirable that *simultaneous* observations, *on the plan*, and *at the periods*, recommended at page 190 of our last volume, should be made throughout our country. COM. PUB.

Franklin Institute.

Conversation Meeting.

The fourth monthly conversation meeting of the season was held at the Hall of the Institute on Thursday evening, 28th of December.

Mr. James Swaim exhibited, for the second time, his powerful magneto-electric machine, and, as on the former occasion, it excited much astonishment in all who had the temerity to try its effects, and produced no little amusement at the expense of the experimenters.

Mr. Andrew Stevens put in operation a model of Mr. Davenport's galvano magnetic machine, similar to those at the Masonic Hall.

Dr. Robert Rogers presented to the Institute one of his revolving galvanic batteries, designed to maintain constant activity.

A very neat specimen of statuary, from the chisel of Mr. Drache, was presented to the Institute by that artist.

Mr. W. F. Ketchum exhibited his method of increasing the adhesion of locomotives on inclined planes, by means of small driving wheels fixed on the axles, outside of the large wheels, and adapted to an angular, or wedge shaped rail, laid on the steep grades, and raised above the ordinary rail.

Numerous samples of American manufactured hardware and cutlery were exhibited by Messrs. W. H. Carr & Co., Messrs. Curtis & Hand, and Messrs. English and Huber, also some beautiful specimens of American cut glass, by Mr. Wm. Muzzy.

The Hall was visited in the course of the evening by Governor Ritner, and a number of other distinguished strangers, who expressed much gratification at witnessing the interesting display of scientific and mechanical novelties.

Mechanics' Register.

LIST OF AMERICAN PATENTS WHICH ISSUED IN APRIL, 1837.

With Exemplifications and Remarks by the Editor.

52. For improvements in the *Manufacture of White Lead;* Peregrine Phillips, Campbell county, Kentucky, April 17.

The lead is to be rolled into sheets, or shotted, but it is preferred to be feathered, that is, granulated, by pouring it, in a small stream, into water. The prepared lead is then to be placed in a vat with a perforated false bottom at about its middle, where the lead is to be sustained. A pump is to be placed so as to pass through the false bottom, or in such manner as to allow the liquid contained in the vat to be pumped up. A steam pipe, of pure tin, &c., is to pass once, or more times, round within the vessel; and a tube through which air may be blown, is also to pass into the vat, below the false bottom. Distilled vinegar, or dilute acetic acid, containing about two or three per cent of dry acetic acid, is then to be poured into the vessel, to such height as not to interfere with the passage of air through the feathered lead. The pump is then to be worked, and the liquid to be so distributed by it as that the lead shall be kept constantly moistened. The acid may be kept at a temperature of 85 or 90 degrees by the passing of steam through the steam pipe. A blowing apparatus is to be kept at work at the same time, throwing in atmospheric air, to oxidize the lead as it passes up among it, which oxide will be dissolved by the acid, forming an acetate. When saturation is perfect, the fluid is to be drawn off into a

cooler, and a fresh portion supplied to the lead, and this repeated until the whole is dissolved. The saturation may be judged of by the specific gravity ceasing to increase.

The saturated liquid is to be put into a vat, called a carbonating vat, constructed like that for saturating, but, instead of lead, having twigs, or pebbles, &c., upon the false bottom. Upon this brushwood, &c., the saturated liquid is to be pumped, whilst a quantity of carbonic acid, or a mixture of it with other air, is to be forced into the vat below the false bottom, which as it passes up, will convert the acetate into a carbonate, and this, being insoluble, will fall to the bottom in the form of an impalpable powder. When the precipitation ceases, the liquid is to be drawn off, and used again in the first vat, and so on continuously. The precipitated lead is to be thoroughly washed, then dried, and the process is completed.

The whole apparatus used is clearly described, and full estimates are given of the respective ingredients necessary to produce the desired reaction. The following are the claims.

"I claim as my own invention, *first*, the oxidation of the lead, and dissolving of the said oxide by means of pumping or throwing diluted acetic acid, or vinegar over lead when in a state exposing a large proportion of surface, at the same time drawing, or forcing, a current of atmospheric air through the interstices of the said lead; and I claim this only for the purpose of preparing a liquor to be used in the manufacture of white lead.

"I claim *secondly*, the pumping or throwing the aforesaid solution of lead over any substance or materials placed in an atmosphere composed wholly, or in part, of carbonic acid gas, or for pumping or throwing the aforesaid solution into the atmosphere as before said, so that it shall fall down through the said atmosphere, for the purpose of manufacturing white lead.

"I claim *thirdly*, the purifying of the vapour of burning charcoal by causing the same to pass through a stratum of pebbles, or other substances, which substance shall be kept moist by the constant or occasional injection of water over them. And I claim this only for the purpose of assisting in the manufacture of white lead."

This latter claim refers to the removal of all dust, or other impurity, which might enter with the gas, and injure the colour of the lead.

We doubt the economy of the process of forming the acetate in the first instance, and are not aware of its superiority in any respect, to the usual mode of manufacturing that salt from litharge. The carbonating is substantially the same with the French process described in Gray's Operative Chemist, and in other works; the particular management described by the patentee is all that he can hold, as being the only novelty presented to us.

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53. For improvements in *Smoke Stacks, Flues, &c.*; James Stimpson, City of Baltimore, April 17.

The object in view is said to be so to construct the chimneys, or flues of steam engines, smith's forges, &c., as to generate heat, and prevent the escape of sparks, ashes, cinders, or soot. The instrument is denominated the "draught accellerator, and centrifugal spark catcher." The contrivance itself is somewhat complex, and the description of it much more so. Much space is occupied also by directions to the workmen how to cut and join the separate parts, which is altogether foreign to the matter in hand. A part of the flue is to ascend in a spiral form, and in speaking of this, we have some philosophical information which seems to furnish one of the pro-

perties of a patentable article, novelty. Not to mar the affair, we will quote the passage.

"I should recommend the spiral to be so formed as to have the ascent go round with the sun, like a back handed screw;—as nature inclines fluids, air, &c., to move, when in a spiral or circular manner, with the sun. And as it is as easy to make it ascend one way as the other, it would be best to let nature have her own way."

The smoke from a steam engine furnace, &c., is to ascend up a pipe to some distance in the usual way; there is then an opening made in the side of the pipe, through which the draught is to pass into a flue ascending spirally around the pipe as its shaft, or centre; an outer case covers the outer edges of the spiral thread, so as to make an enclosed flue. This it is said, will give to the sparks, dust, &c., a centrifugal force, inclining them to fly off tangentially; and to enable them to do so, there are slats, or openings in various parts of the outer case of the spiral, which openings are covered by troughs, called receivers, leading downwards, in which the sparks, ashes, &c., are to be precipitated to the bottom, where they are received and retained until removed.

The claim is "the combination of the spiral flue, with the outlets and receivers, constructed as above set forth, or in any other manner whereby a centrifugal force is, or shall be, obtained," &c.

We wish that this contrivance may have the effect of removing a great nuisance in rail road travelling, but we do not anticipate it, being apprehensive that but a small portion of the sparks and ashes will leave the ascending current and find their way into the receivers.

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54. For an improvement in the *Tongues of Power Loom Shuttles;* Comfort B. Thorp, Smithfield, Providence county, Rhode Island, April 17. (See specification.)

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55. For a *Revolving Hand Rake for hay or grain;* Stephen Coats, Shoreham, Addison county, Vermont, April 17.

This revolving hand rake consists of a rake head which is about six feet long, with teeth about two feet ten inches long, running through said head, and projecting out on opposite sides. To this head is affixed a pair of shafts, within which the person drawing the rake is to walk, a strap passing in front of him to aid him in drawing. The rake head revolves on the hind ends of the shafts, in loops formed by iron straps, there being catches to stop the head in a proper position for raking, and a lever at the command of the operator, by which the rake can be disengaged when fully loaded, and thus allowing it to revolve so as to bring the opposite row of teeth into action. The claims are to the particular mode of constructing the operating parts as described in the specification.

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56. For a machine for *cramping leather for the legs of boots;* Jesse Van Winkle, Rochester, Monroe county, New York, April 17.

This machine, in its general construction, is like several others, differing only in certain special points of structure, which we shall not attempt to explain. The claim is made to the "slides or sliding planes, with the projecting bars, or narrow plates, for removing the wrinkles from the leather."

57. For improvements in the mode of *Propelling Boats on canals and rivers;* John Finlay, City of Baltimore, April 17.

A rail, or string piece, is to be placed along the side of the canal, or other water, or it may be so supported by posts as to stand above the boat. This rail is to be embraced between two friction wheels, bearing on opposite sides of it, one of which wheels is to be made to revolve by steam, or other power, on board the boat; the frame which carries the wheels being so constructed that it may vibrate, and adapt itself to the level of the water. It is proposed sometimes to place rails upon a tow path, with a carriage adapted thereto, to be drawn by horses, instead of allowing them to draw directly by a tow line attached to the boat.

"Now what I claim as my own invention, and wish to secure by letters patent, consists in the application of a string piece, or rail, secured to posts placed near the edge of the water in canals, or over the tops of boats used on canals or rivers, and applying to the sides of said string piece, or rail, a wheel or wheels attached by a frame to a boat, with joints so as to adapt the whole to the depth of the water, operating nearly in a horizontal line; and to which wheel or wheels I apply the propelling power, causing the boat to move with velocity and without injury to the banks of the canal. I also claim the use and application of the guide frame with the friction rollers, to keep the boat parallel with the canal. I also claim the use and application of a frame with wheels to operate on the road above described, for horses to move with on the tow path to propel boats on canals; said frame having two wheels whose planes are oblique to the horizon, secured by friction rollers acting on opposite sides of the rail, being easily removed so as to disengage the wheels from the rails when boats are required to pass each other, or for any other purpose. I also claim the use of my invention on the ice during winter, the boats being placed on runners."

A plan for propelling upon canals, in some points resembling the foregoing, was patented by Prof. Chas. Bonnycastle, of the University of Virginia, on the 21st January, 1834, and is described in our 14th volume, p. 118.

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58. For an improvement in the *Standing Press;* Joel Barns, City of Philadelphia, April 17. (See specification.)

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59. For an improvement in the manner of *Constructing Rail Roads;* Uri Emmons, Freehold, Monmouth county, New Jersey, April 17. (See specification, Vol. XIX, p. 480.)

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60. For improvements in *Fire Arms;* Elijah Fisher, Springfield, and Dexter N. Chamberlain, Boston, Massachusetts, April 17.

Behind the barrel of the gun, or rifle, a longitudinal slat, or mortice is made, into which the back end of the barrel opens. This rectangular opening is to receive a block, or piece of metal, which is so fitted as to slide easily through it. Into this piece of metal, several chambers are bored parallel to each other, and capable of being brought in succession to coincide with the bore of the barrel, a nipple being fixed over the rear of each chamber to receive a percussion cap. There are also the contrivances necessary for arresting the sliding block, and holding it in place, and also for forcing it into close contact with the barrel at the time of discharge.

"We claim as our invention and improvement, *first*, a piece or block of metal, having any number of chambers therein to contain separate charges

of powder, balls, and shot, to slide in a rectiliniar direction through a slat or passage formed in such a manner between the barrel and breech, as to admit of the axis of each of the chambers to be brought in succession in a right line with, or to correspond to, the axis of the barrel. *Second.* The mode of confining the piece or block of metal in different positions by means of a pin, projecting from a sliding piece of metal, and notches formed in the edge of the face of the piece, or block of metal. *Third.* Forming the key wedge shaped, for the purpose of pressing the block close against the side of the slat, or end of the barrel, to prevent windage."

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61. For improvement in the *Loom for Weaving Coach Lace, &c.;* Erastus B. Bigelow, West Boyleston, Worcester county, Massachusetts, April 17.

This coach lace power loom is very fully described, and well represented in the drawings. The novelties, also, are distinctly claimed; but we shall not attempt an epitome, as without the drawings it must be obscure; the insertion of the claims would also be useless, if given alone.

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62. For a Furnace for *Smelting Iron Ore by the use of Anthracite Coal;* George E. Sellers, Upper Darby township, Delaware county, Pennsylvania, April 20.

In this furnace the fuel is to be contained in a stack distant from that in which the smelting is to be effected. The latter is to contain the ore, with the necessary flux, and such portion of coal as may be required to carbonate the iron. The tuyere is in front of the fuel stack, and on the opposite side of this is an opening, called a concentrating flue, leading into the smelting stack, and in this passage there is a depression forming a timp, or receiving chamber, into which the metal runs as it is smelted, the bottom being inclined for that purpose. The necessary devices for performing the different operations appropriate to a furnace are, of course, appended to this. It is not pretended that the placing the fuel in one stack, and the mine in the other, is, by itself, new; but the novelty claimed consists in the particular construction of the furnace in its combined character. The patentee says, "I do not intend to claim the parts described in their individual characters. There is nothing new, for example, in the mode of feeding adopted by me, or in the principle of passing the blast through a stack containing fuel only, and causing the blast and heated air, therefrom, to enter a second chamber containing the ore to be smelted, this having been previously performed, or essayed. But what I do claim is that particular arrangement of the respective parts of the within described furnace by which it may be distinguished from all those which have preceded it; intending by this particular arrangement, the manner of connecting the main furnace for fuel with that containing the ore to be reduced, by a concentrating flue, within which is contained a receiving bed for the reduced metal, constructed and operating in the manner herein set forth, combining the same with the smaller flue above it, for the purpose herein fully shown. I also claim the provision for removing the slag from the fuel under the main furnace, by means of one or two openings constructed for that purpose, upon the principle, or in the manner, described."

"The smaller flue," above referred to, is one situated above the concentrating flue, and like it leading from the fuel stack into the smelting stack; its design being to conduct a portion of the heat into the smelting stack at

such height above the bottom as may be useful in preparing the materials for the full action of the blast.

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63. For a machine for washing *Iron and other ores;* Frederick Fredly, Logan township, Centre county, Pennsylvania, April 20.

The ore is to be put into a long polygonal receiver, which turns on gudgeons like a dash wheel, and this is made to revolve with its lower side dipping into a trough or cistern containing water. The axis of the receiver is inclined, the ore is put in at the upper end, and a portion of water is also scooped in at every revolution. There is an opening at the lower end for the materials to pass out. The things claimed are certain peculiar points not possessing more novelty than was absolutely necessary to justify the granting of a patent. They consist in "the inclined strips at the ends of the polygonal case for directing the ore from the upper to the lower end of it, and into the inclined spouts. The inclined spouts at the lower end of the case, and the scoops at the upper end."

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64. For an improved mode of *Applying the Blast to Furnaces;* John Barker, City of Baltimore, April 20. (See specification.)

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65. For a new *Body for Hats;* Hugh Moore, City of New York, April 28.

The following is the whole substance of the specification. "The body is formed of cloth, the warp of which is strong cotton yarn, and the weft of alternate layers of strong cotton yarn and whalebone; or otherwise made of split whalebone attached to any kind of cloth by an adhesive water proof composition. The bodies, of both kinds, are joined at the sides by needle work. The brims and crowns are made of the same material, and I have also made them with brims of Canton flannel, and felt, and the crowns of layers of muslin of different degrees of strength.

"What I claim as my invention, and desire to secure by letters patent, is the application of whalebone to hat bodies, by which they will be rendered more elastic and durable than those made of felt, calico, or any other substance."

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67. For a *Furnace for the Manufacture of Shear Steel, and of Cast Steel,* by the use of anthracite coal; Simeon Broadmeadow, City of New York, April 5.

The furnace described is said to be one which is calculated to make about one hundred and sixty pounds per day. The ash pit is to be in the usual form, about eighteen inches high, five inches diameter at bottom, and seven at top. The furnace part eighteen inches in diameter, and four feet six inches high from the grate bars: surmounted by a flue forty feet in height, and nine inches square.

There are to be six small interior flues, which are to surround the furnace inside, each having an aperture of about an inch square. These flues extend from the grate bars to a point a little above the top of the crucible, and, of course, built with the furnace, giving to its interior somewhat of a hexagonal form. They serve to admit air at their lower ends, and to deliver it at their upper ends, below the surface of the burning fuel, so as to produce perfect combustion about the upper part of the crucible. These flues may be varied in number.

The principal things relied on are these interior flues, and the great height of the furnace stack, "that is to say, a chimney of extraordinary height for the size of the furnace, and furnished with interior flues, operating in the manner, and for the purpose, set forth."

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68. For a *Furnace for Smelting Iron by means of Anthracite Coal;* Simeon Broadmeadow, City of New York, April 5. (See specification.)

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69. For an improvement in the *Lamp for Lighting Houses,* for which Letters Patent were obtained on the 6th of October 1835; Samuel Rust, City of New York, April 20.

The kind of lamp which is the subject of this patent, has the wick, which is flat, raised and depressed by a roller in the stopple, or burner. Mr. Rust has introduced several improvements into this kind of lamp, and has obtained patents for them at a date subsequent to that now under notice, and which will receive attention in due course. One of the claims made in the present instance, is to "the casting or making of the portion which constitutes the usual stopple, and the vessel of the common close lamp (which holds the oil) all in one piece." There is also a claim made to the "constructing of the roller in such lamps movable, to take out of the tube, or lamp, and put in at pleasure." As the stopple is solid with the lamp, it is necessary to leave an opening in the top for filling the lamp, and this is covered by a flat cap, or valve, which turns on a pin, which device is claimed as combined in a lamp of this description. There are some minor claims to particular things which need not be mentioned here. As respects the lamps themselves, we have them in use, and prefer them very much to the house lamps as commonly made.

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70. For improvements in the *Rotary Steam Engine;* Roger M. Sherman, Fairfield, Connecticut, April 25.

We have had repeated occasions to record our want of confidence in the successful employment of rotary steam engines, and we have not yet arrived at a period when we can announce a change of opinion. The numerous engines of this kind which have been patented here and in Europe, might probably be arranged as constituting five or six different species, each of which has been presented under various modifications in matters of detail, by which modifications it has been hoped that the particular difficulties, and objections found to exist to them might be removed. Our opinion, however, is, that there must be some new species discovered before the rotary will become a competitor with the reciprocating engine, and that, therefore, the one now before us, will share the fate of its predecessors. We cannot, without the drawings, furnish an account of the new devices proposed by the present patentee. Some of them have a near resemblance to such as have been previously used, although differing enough from them to justify the grant of a patent. The following is an abstract of the claims.

The grooves in which the valves, or pistons rise and fall in a revolving chamber, or the so adapting the valves that they shall be rendered close by the pressure of the steam, without packing. The application of pressure by means of a spring upon the stop, causing it to bear upon the sides and bottom of the chamber, and prevent the escape of steam, without packing. The combination of packing rings with lateral springs acting thereon

so as to prevent the escape of steam between the cap and the chamber, without the use of packing; and the pressure of the cap upon the revolving chamber by means of springs, to effect the same object."

71. For a *Cradle for Cutting Hemp;* Wilson A. Larimore, Paris, Bourbon county, Kentucky, April 25.

This is a modification of the common cradle, fitting it to the purpose of cutting hemp by hand. The claim is to "the construction of a bow, or guard, around the points of the fingers, and its extension to the post. Likewise the cord which confines the bow, and extends to the sneath. Likewise the confining of the scythe at the point to the frame, by a screw or otherwise. Likewise the hoop confined on, or near, the back of the scythe."

The object appears to be to render the instrument firm and steady, for cutting the heavy substance to which it is to be applied.

The points of the fingers are inserted into a hoop, connecting them together there as well as at their back ends, and from the frame thus formed a rope extends to the upper end of the sneath, to support said frame.

72. For an instrument for *Measuring and Draughting, preparatory to cutting out Garments;* William C. Bishop, Ovid, Seneca county, New York, April 25.

We have a specification and drawing of this instrument, but do not suppose the subject of sufficient general importance to justify the expense of an engraving, and the space for the description. The instrument consists of flexible graduated metallic straps, to which measuring tapes are attached, and the claim is to "the particular mode in which they are connected and arranged," which so far as we can judge in a matter foreign to our general pursuits, appears to adapt them well to the purpose intended.

73. For an improvement in the *Cotton Gin;* Alexander Jones, City of New Orleans, April 25.

The principal improvement in this cotton gin consists in the manner of feeding the seed to be cleaned. The seed is put into hoppers, the bottoms of which are formed of parallel bars, the spaces between these bars being such that the seed cotton may be drawn through by the teeth of revolving feed plates, constructed for that purpose. To regulate the feed the hoppers are made to raise and lower, giving to the teeth of the feed plates more or less hold. The claim is to "the method of feeding the cotton to the saws by means of hoppers and feeding cylinders, constructed and operating substantially upon the principles set forth."

74. For a *Bodkin for inserting Corset Rings;* Jonathan S. Turner, Middletown, Middlesex county, Connecticut, April 25.

Corset, or other grooved rings, are to be inserted into cloth or canvass by means of an instrument that will make a hole in the cloth of the size of the neck of the ring to be inserted, and at the same time convey the ring into the cloth. A taper bodkin is to be made of ivory, or other suitable material, and this is to be cut across at such distance from the point where it is equal to the diameter of the grooves, the two sections forming a point and handle. From the handle a pin is to project about an inch in length, and of a size fitting the hole in the corset ring. The point is to be bored to receive the pin projecting from the handle, and the instrument is complete.

To use it the corset ring is first put upon the pin, and the point then passed on to it, so that the ring is embraced between the two sections. The point is then forced through the cloth, up to the ring, and with the nail, scissors, or other instrument, the cloth around the hole is forced over the lip into the grooves. The claim is to the instrument as above described.

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75. For an improvement in *Many Chambered Cylinder Fire Arms;* Daniel Leavitt, Cabotville, Hampden county, Massachusetts, April 29.

This is one of those fire arms which have several chambers bored in a cylinder, the axis of which is parallel to the axis of the barrel of the gun, and which chambers can be successively made to coincide with the said barrel. Such revolving cylinders have heretofore been made flat at the end which fits against the barrel, and the present improvement consists in substituting a hemispherical, or convex form for this flat one, the back end of the barrel being so hollowed as shall make it fit accurately on to the cylinder. The object in view is to prevent the danger of accidental explosion in chambers not brought up to the barrel; a thing which is liable to occur in the flat ended cylinders from that portion of the charge which escapes between them and the barrel, but which cannot come into contact with the chambers when the end is convex.

"What I claim as my improvement, is the giving to the chambered or forward end of the cylinder a convex form, by which the ignition of the charge in a chamber contiguous to that which is being fired, is prevented, upon the principle, and in the manner herein set forth."

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76. For *Many Chambered, non recoil, Fire Arms;* John W. Cochran, City of New York, April 28.

In fire arms of this construction, the chambers are made around the periphery of a a short cylinder, say three inches and a half in diameter, and three fourths of an inch thick, said chambers being bored in towards the centre, and made somewhat conical. This is placed behind the barrel of the gun, so as to revolve horizontally when the gun is in a position for firing. Percussion caps are placed on nipples on the under side of the cylinder, there being suitable guards to prevent their accidental discharge. The following is the claim.

"What I claim as my invention in the within described many chambered fire arms, is the combination of a many chambered cylinder, the chambers of which are formed around the periphery in the way herein described, with a rifle, pistol, carbine, or other barrel, and combined also with the stock of such fire arm by means of the stock straps, connected substantially in the manner set forth. I also claim the combination of the percussion cap guard, together with the thin circular plate under it, with a cylinder constructed and connected as above set forth, for the protection of the percussion caps. I also claim the manner of connecting the barrel, in arms so constructed, with the rising piece of the under stock strap, by screwing it therein; the whole combined so as to constitute a fire arm substantially the same with the foregoing."

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77. For improvements in the *Many Chambered, non recoil, Fire Arms;* John W. Cochran, City of New York, April 29.

A principal object in the patent before us, is to construct the fire arms last described in such manner as to allow of the ready removal of a cylin-

der which has been exhausted, for one which is ready charged, by which means five or six cylinders contained in a belt, may be successively used, two or three seconds being sufficient to allow of the removal of one, and the substitution of another. For this purpose the upper stock strap, forming the upper side of the mortice, or opening, in which the cylinder is contained, is hinged to the back end of the barrel, so that it can be released by touching a thumb spring, thrown up, and the cylinder exchanged. A second improvement consists in leaving a space in the hinge joint of this strap, through which a portion of the fire and smoke which escapes between the cylinder and the barrel, may pass, this opening being immediately above their junction. The claims made are to these two distinct improvements.

It may be proper to observe that the application of Mr. Cochran for improvements in fire arms had been many months depending in the patent office, prior to the fire in December, 1836, when his papers and models shared the common fate of every thing contained in that department. Such also was the case with numerous other applications, and it is now noticed to account for the delay in issuing the patents, arising in the first instance from a desire on the part of the applicant to remodel his specifications in some particulars, and subsequently from the burning of the office.

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78. For an improvement in the *Spoke Shave;* Ira L. Beckwith, Quincy, Norfolk county, Massachusetts, April 29.

In this spoke shave there is a steel roller in front of the cutting edge of the knife, which roller turns freely on pivots at its ends; it extends the length of the knife, taking the place of the wood or metal which usually constitutes the front of the throat. The bearing of this roller is adjustable, so that as the knife wears away, it may be advanced towards it. A thin plate of steel, called a cap, is to be screwed on to the under side of the knife, to cause it to operate like a double iron plane, and shave against the grain. The claims are to these particular improvements.

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79. For an improvement in the *Joints of Carpenters' and other Rules;* Lemuel Hedge, City of Hartford, Connecticut, April 29.

This rule joint turns upon double centres, much in the manner of card table hinges, so that when the rule is closed the joint end will be square, like the two opposite, or opening ends. To insure the opening and closing correctly, there are two angular projections on the brass plates constituting a part of the joint, with corresponding shoulders, which though simple in construction, cannot be readily explained without a drawing. Since the patent for this joint was obtained, the same individual has obtained another for an improvement in it, which will come to be particularly noticed in due course.

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80. For an improvement in the *Spring Saddle;* Moses Baldwin, Cincinnati, Ohio, April 29.

The claim made is to "two thigh webs, and an additional pair of draw-downs; also the position of the springs and cantle plate; using for the purpose of making the two latter, iron, steel, or brass wire, varying in size to suit the weight of the rider."

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81. For improvements in the *Loom for Weaving various kinds*

of Fabrics; Christian W. Schonherr, of the kingdom of Saxony; patent dated March 31, but issued April 29.

Under the new Patent law, patents may be dated at a period prior to their issuing from the office, but not exceeding six months; this may account for some apparent discrepancies of dates in our lists.

This is a very ingeniously constructed hand loom, the description of which extends to a considerable length, and refers to numerous figures in the drawings; the particular construction of the parts claimed as improved cannot, therefore, be furnished in a brief way, but some idea of the design may be obtained from the claims, which are:

"*First.* The modes of actuating the treddles by levers and horizontal bands passing under pulleys, and springs, as described and set forth.

"*Secondly.* The arrangement of the picking straps, with the loop, or bridle, and horizontal check strings, leading to the spring lever; also the shuttle catcher bar, with its strap and spring rod.

"*Thirdly.* The mode of actuating the lathe, by means of a cam or tappet, together with the straps and their guide pullies, as also the spiral springs attached to the sword, for the purpose of drawing back the lathe as described.

"*Fourthly,* The arrangement of machinery as described, by which the giving out of the warp and taking up of the cloth is effected and regulated.

"*Fifthly.* The improved driving pulley as described, which, when the loom is turned by hand, may be made to act as a fly wheel.

"*Lastly.* The form of shuttle with the cavities described, and of the picker to be used therewith."

Specifications of American Patent.

Specification of a Patent for an improvement in the mode of securing or holding the cop on the tongues of Power Loom Shuttles; granted to Comfort B. Thorp, *Smithfield, Providence county, Rhode Island, April 17th,* 1837.

My improvement consists in a mode of more effectually securing and holding the cop, or woof, upon the tongues of the common power loom shuttle, than the mode now in use, preventing the cops, or woof, from sliding off from the tongues while weaving, especially the last part of them which so frequently slips from the common smooth tongues, and draw into the web, injuring the cloth, and wasting yarn.

My improvement consists of ridges, or parts jutting from the surface of said tongues, protruding into the cop, against which the innermost turns or coils of the woof will lodge and prevent the cops from sliding from the tongues.

There are various ways to form or produce such projections or protuberances, such as cutting notches in of a saw tooth form, the points or cutting part of which will stand towards the heel or pivot of the tongues, and about five eights of an inch apart on each corner, and so arranged that neither of them will come opposite to another. The square of the tongue should be equal to the hole in the cop. Also by forming a worm, or spiral projecting lip or edge around the surface of the round tongues, or by cutting notches therein.

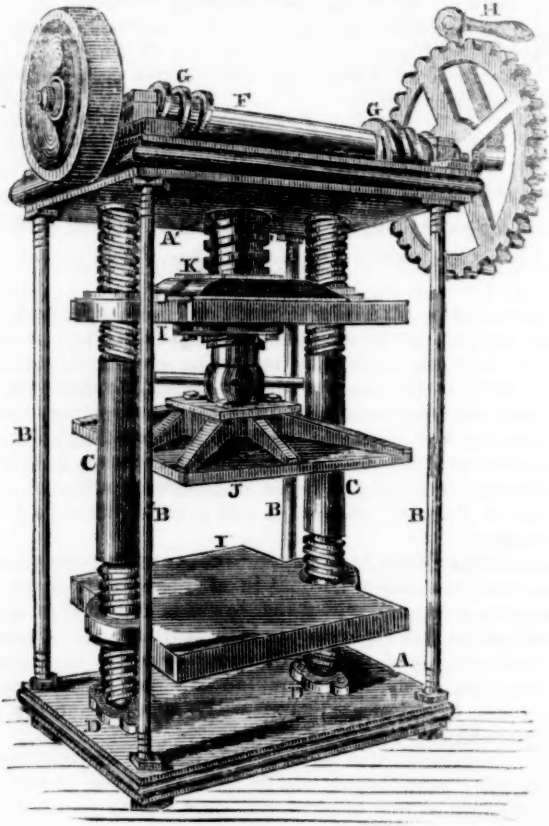
The most convenient way to form and use the improvement on the common smooth round tongue will be to wind a piece of wire around it, spirally, beginning at the head of the tongue near its pivot, and form-

ing about eight turns, more or less, onward towards the point, each turn should be three eights of an inch apart, or thereabout. The wire should be the sixteenth of an inch in diameter, and confined to the tongue by soldering. It is necessary that the tongues should be made so small in size as to protrude into the cop with ease, before the wire is put on to said tongue. The most handy way to put the cop on to the screw tongue, will be to slip the cop on to its point until it comes to the worm, and then with one hand hold the cop and whirl the shuttle round.

What I claim as my invention, and desire to secure by Letters Patent, are the above described projections which protrude into the cop, for the purpose of more effectually securing and holding the cop or woof on upon said tongue. Also the application of the worm, or the spiral projecting lip or edge to the round tongue, as herein described, for the purpose of holding and preventing the cop from slipping off from the tongues of the shuttles while weaving.

COMFORT B. THORP.

Specification of a patent for a standing Press, granted to JOEL BARNS, *City of Philadelphia, April 17th* 1837.



To all whom it may concern, be it known, that I, Joel Barns, of the City of Philadelphia, have invented a new and improved Standing Press, to be used for the pressing of every kind of article to which such presses are adapted; and I do hereby declare that the following is a full and exact description thereof, reference being had to the drawings which accompany, and make a part of this specification.

A, A′, are the bottom and top plank, or plates, of the press, forming a part of its frame. B, B, are rods of iron passing through the top and bottom plates, and firmly secured to them by screw nuts, or otherwise. C, C, are two screw shafts, each of them having a right handed screw at one end, and a left handed screw at the other, a blank space, not formed into a screw, being left between them. These screw shafts pass through the plate A′, and revolve within a suitable collar; they also revolve in steps D, D, at their lower ends. A toothed wheel, or pinion, not seen in the drawing, is firmly fixed on each of these shafts, just above the upper plate A′, and a horizontal shaft F, carrying two endless screws G, G, which mash into the wheels or pinions, upon the screw shafts; G, G, when turned by mean of the winch H, or by a wheel and pinion, or any other suitable gearing, cause the screw shafts C, C, to revolve. I, I, are two plattens, or followers, having nuts, or screw boxes, on or within them, adapted to the screws of the shafts; and it will be apparent that by the revolving of the shaft F, these plattens, or followers, will be made to approach towards, or to recede from each other as may be desired. A third platten, or follower, J, has a screw K, attached to, and swiveling on it, in the manner of the ordinary screw press, the female screw or nut, within which it works, being fixed in the platten I; the upper end of this screw passes freely through a hole in the centre of the upper plate A′. The use of this platten is to save time by the ease and rapidity with which it may be raised or lowered, instead of raising or lowering the two plattens first named. To effect this with the greater facility, I usually make the thread of the screw K, considerably coarser than that on the shafts C, C, the power of the press being dependent, in a great measure upon the cutting the latter as fine as is compatible with the necessary strength.

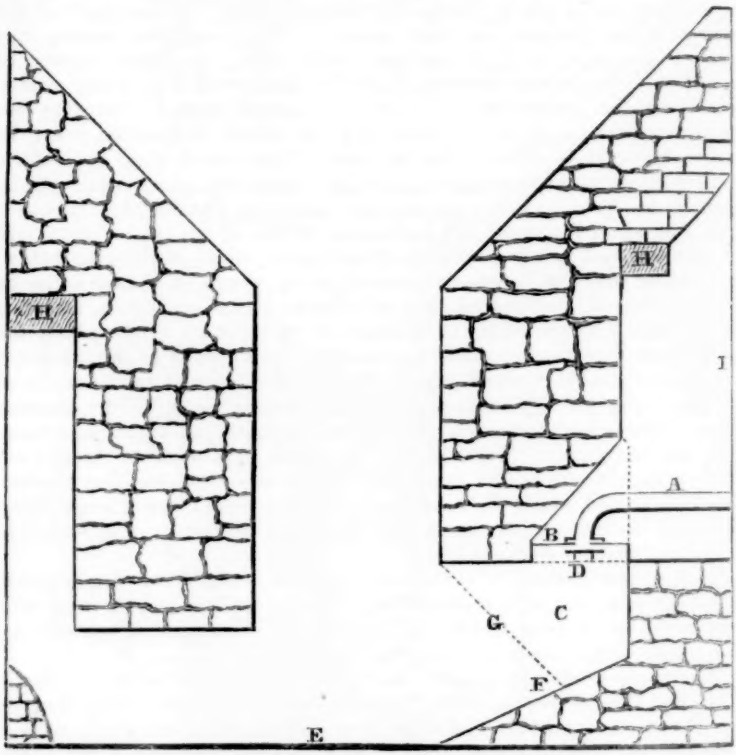
It has not been thought necessary to give any particular dimensions, or the proportions of the respective parts to each other, as these will vary with the purpose to which the press is to be applied, and can be duly adjusted by any competent workman.

Having thus fully described the construction of my newly invented press, and the manner in which the same operates, I do hereby declare that I do not intend to claim the mere application of a shaft with a right and left handed screw upon it, or either of the parts of the press described taken individually, and alone, as my invention, these being well known as elements of other machines; but what I do claim, and wish to secure by Letters Patent, is the combination of these parts constituting a press with three plattens, or followers, two of which are operated on by shafts having right aud left handed screws, turned by a gearing constructed and arranged substantially in the manner herein described, whilst the third platten is raised and lowered by means of an independent screw, in the manner herein fully set forth.

JOEL BARNS.

Specification of a Patent for an improved mode of applying the Blast to furnaces, granted to JOHN BARKER, *City of Baltimore, April 20th*, 1837.

To all whom it may concern: be it known, that I, John Barker, of the City of Baltimore, in the state of Maryland, have invented a new and improved mode of applying the Blast to Furnaces for the smelting, or fusing of metals, and which is particularly applicable to those erected for the manufacturing of iron: and I do hereby declare that the following is a full and exact description thereof, reference being had to the drawing which accompanies, and makes a part of this specification.



The drawing shows a section of an ordinary sized smelting furnace, and represents such part thereof, as is necessary to a clear understanding of my invention, which consists in a mode of introducing the air from the blowing apparatus diffusively, without impinging upon the ignited fuel as it does when introduced through the tuyere in the ordinary way; by which diffusion there is an essential difference in the results produced, the action of the air being from the very commencement of its introduction, by gradual and easy pressure.

A, represents the blow pipe, connected with the blowing apparatus,

and passing through the tuyere arch to the furnace. This pipe should not be less than three inches in diameter, but it may be made much larger, and its being so will rather aid than abstract from the result at which I aim; the quantity of air introduced through it, is altogether independent of its size, this being governed by the number of strokes made by the pistons, and the capacity of the blowing apparatus. From the blow pipe A, the air passes into a square, round, or other shaped box, B, made of sheet or of cast iron, the horizontal section of which may be a square foot, more or less, and its depth about two inches. The lower face of this box is preforated with numerous holes, through which the air is to pass into the chamber C, of the furnace, by which means the blast will enter over the whole area of the face of the plate. To prevent its impinging too forcibly upon the centre portion of the plate, a small plate D, may be placed directly under the blow pipe, so as to diffuse the blast; or a similar result may be obtained by making the perforations about the middle of the lower plate much smaller than towards its outer edges. The bed stone E, may be continued in a horizontal position under the chamber C, but I prefer to give it an inclination at that part, as shown at F, as this will dispose any matter in fusion to descend towards the middle of the furnace. When this part is constructed, as shown in the drawing, the coal and other materials in the furnace, as they descend, will assume a position near the chamber C, something like that shown by the dotted line G, leaving a clear space under the box B, for the admission and expansion of the air, which will consequently, be forced into the fuel by an equable pressure over a large surface, as intended by me. In the position given to the box B, also, there will be a perfect security against its being obstructed by the coal, or other matter within the furnace. There may be two or more blow pipes, operating in the way described, just as there may be two or more tuyeres when the blast is introduced on the ordinary plan.

Instead of the box, B, a trumpet mouthed pipe may be used, as may also other analogous contrivances to diffuse the blast in the chamber, which diffusion is the great object that I have in view; and for this purpose my furnace must always be so constructed as to have a chamber, operating like that marked C, free from fuel, through a space sufficient to allow a large surface to be exposed of that portion of the burning fuel into which the air from the blast is first to enter, which surface is represented by the dotted line G. In whatever way, therefore, the *proper quantity* of air is introduced, provided it be such as will allow of its *diffusion in a chamber*, constructed so as to operate like that marked C, before it comes into contact with the burning fuel, my purpose will be accomplished, and my invention adopted. This may be done even when the blast is introduced into the chamber by the common blow pipe although it should be directed towards the burning fuel, as the chamber is intended to equalize the blast before its contact with the burning fuel. The chamber C, for example, may be extended in height, by enclosing that part of the tuyere arch shown by the dotted line H, and blowing into it by the ordinary blow pipe which would then perform the office of the pipe A, the box D being removed.

Having thus fully described what I believe to be the best mode of attaining the end which I propose, namely, the introduction of the blast

into a furnace under an equable, but comparatively light, pressure, by diffusing it, at its entrance, over a large surface, without diminishing it in quantity, I do hereby declare that I do not intend to limit myself to any particular proportions, or dimensions of the parts of my apparatus, or to any precise location thereof; but I claim as my invention the diffusing of the blast *in a chamber* as it enters a furnace, in the manner, and for the purpose, herein set forth, whether the apparatus be constructed in the way described, or in any other which is substantially the same.

JOHN BARKER.

Specification of a Patent for a mode of constructing Furnaces for the smelting of Iron Ore by the use of hard, or anthracite coal; granted to SIMEON BROADMEADOW, *City of New York, April* 5, 1837.

To all whom it may concern: Be it known, that I, Simeon Broadmeadow, of the City of New York, in the State of New York, have invented a new and improved mode of constructing Furnaces for the smelting of iron ore by the use of hard, or anthracite coal, as a fuel, and I do hereby declare that the following is a full and exact description thereof.

The dimensions of the respective parts of my furnace, which I am about to give, are such as will designate one of ordinary size; my object therein being to afford a clear view of its general construction and arrangement, without intending to limit myself to the precise admeasurements set down, but rather to exhibit a general character by which any competent iron master will be enabled to see the difference between my furnace, and all those which have preceded it, and also to construct the same.

The whole height of the furnace, above the hearth, is twenty-five feet. The form of the stack above the tymp is that of two truncated cones, the bases of which unite at the middle of the stack, whence they regularly taper to the diameter of two feet at the top, and the same at the tymp. The tymp must be eighteen inches long and nine inches deep, as will be seen by the drawing (deposited in the patent office,) which is drawn upon a scale of half an inch to the foot. The hearth below the tymp, where the molten iron lies ready to be drawn off, is three feet square, and two feet deep; whence the slag, or dead cinders, are to be thrown off, as in other furnaces. I use two tuyeres, which at the inlet are each two inches in diameter. The pressure of the blast is two pounds and a half to the square inch.

Should the furnace much exceed the height designated, the weight of the anthracite, and of the ore, will be such as to obstruct the passage of the blast through the mass, and consequently to defeat the process; but by keeping to the proportions given, the pressure of the mass upon the tuyere will be moderated, and the blast will readily find its way to the top of the furnace, and a good working heat be attained.

In using such a furnace, I first heat it by putting in 300 bushels of charcoal; I then charge it by putting in 200 lbs. of hard coal, then 200 lbs. of iron ore, and fifty pounds of lime stone; repeating the charge as the materials sink, treating it in these particulars in the ordinary mode of managing furnaces for making iron. The ore is to be roasted, and otherwise prepared, in the ordinary way; and I of course vary the flux, and other things, according to the nature of the ore to be smelted.

What I claim as my invention, and wish to secure by letters patent, is the construction and employment of such a furnace as that herein described, for smelting iron by means of anthracite, or hard coal; that is to say, a furnace which is substantially the same with that described, in the general structure, proportion, and arrangement of the parts containing the ore to be smelted.

SIMEON BROADMEADOW.

Progress of Practical and Theoretical Mechanics and Chemistry.

A description of the most powerful electro-magnet yet constructed. By the REV. N. J. CALLAN, *Professor of Natural Philosophy in the R. C. College, Maynooth.*

I have lately constructed for the College, an electro-magnet which far surpasses in electric and magnetic power, all the electro-magnets of which I have been able to find a description. The iron bar of our magnet weighs 15 stone; it is $2\frac{1}{2}$ inches in diameter, and more than 13 feet in length. It is bent into the form of a horse shoe; the distance between the poles is 7 inches. A copper wire $\frac{1}{8}$ of an inch diameter is coiled once round the whole length of the iron bar. This wire is divided into 7 parts, each about 70 feet long. A thin copper wire about $\frac{1}{40}$ of an inch in diameter is soldered to one of the thick wires at about a foot from one of its extremities. The thin wire is about 10,000 feet long, it is wound round the magnet in the same direction as the thick wire, and in one continuous coil. By connecting the opposite ends of the seven thick wires with the opposite poles of a powerful galvanic battery, an extraordinary magnetic power is communicated to the iron bar; and, by breaking the battery communication, an electric current of enormous intensity is excited in the long coil of thin wire. I have tried the magnetic and electric powers of this magnet only once. In consequence of making the trial, in presence of about 300 of the students, I was compelled to omit many of the experiments which I intended to make, and which I expect to make before the end of this month.

In exhibiting the power of the magnet, I first used our large battery of 20 pairs of plates, each 2 feet square, and afterwards, a Wollaston battery containing 280 pairs of 4 inch plates. When the opposite extremities of the 7 thick wires were connected with the opposite ends of the battery of large or of small plates, we found it impossible to separate the keeper from the magnet by any force acting in a direction opposite to that in which the magnetic power was exerted. The keeper was a horse-shoe bar of iron about 20 inches long and $2\frac{1}{2}$ inches diameter. The highest point of the arc formed by the keeper was 7 inches. The distance between its poles was the same as the distance between the poles of the electro-magnet. Its weight was about 28 pounds. When the electro-magnet was placed in a horizontal position, and the keeper applied to it, the magnetic power was so great (when the battery of large plates was employed) that the keeper remained without any support, in a horizontal position; and a weight of about 40 pounds, acting at 7 inches from the poles, or at the highest point of the curve formed by the keeper, was required to turn it out of the horizontal position. The

poles of the magnet were so badly ground that a great part of the keeper was at a sensible distance from the magnet.

The magnetic power produced by the 20 large plates was considerably greater than that which was communicated to the iron bar, by the 280 pairs of small plates.

The great electric power of the magnet, or its power of exciting an electric current in the helix at the moment battery connexion is broken, was shown by the most brilliant combustion of charcoal, and by the destruction of animal life.

To one end of the oscillating wire belonging to the electro-magnetic repeater, I tied with a fine metallic wire, a piece of charcoal, in such a way that, on working the repeater, the extremity of the wire and the point of the charcoal should dip simultaneously into the mercury, and should rise simultaneously from it. The opposite ends of the thick wires coiled on the electro-magnet were connected with the opposite ends of our large battery, and the connexion was broken very rapidly by means of the electro-magnetic repeater. As often as the connexion was broken the charcoal and mercury were ignited by the electric current excited in the thick wires coiled round the magnet. The succession of sparks produced by the ignition of charcoal and mercury, was so rapid that they formed one continued blaze of the most vivid light. The combustion of charcoal and mercury was accompanied by a large quantity of smoke, and was much more brilliant than that which is produced by a voltaic current passed from the battery employed, through a pair of charcoal points.

When, by means of an electro-magnetic repeater, a rapid succession of the electro currents excited in the long coil of thin wire, (at the moment of breaking battery connexion) was passed through charcoal points, they were but slightly ignited. But, although the igniting power of the electric current produced in the long coil of thin wire, was very feeble, its intensity was exceedingly great. For, when it was passed through the body of a large fowl, instant death was produced.

I have not as yet examined the decomposing power of our magnet; but I will shortly try it on some of the simple substances.

I found about four months ago, that an electric current capable of giving a shock, and consequently of producing decomposition, is excited in the helix of an electro-magnet on making, as well as on breaking battery connexion, when the thick wire coiled on the iron bar is short, and when the thin wire is long. Hence it is impossible to obtain separately the elements of bodies decomposed by the electro-magnet. For a similar reason it appears to me impossible to obtain separately the elements of substances decomposed by the magneto-electric machine. The shock given by the magnetic helix, on *making* battery connexion is weak compared with that which is given, on *breaking* communication. It increases with the number of plates in the battery.

I am now engaged in making an electro-magnetic engine to be worked by our large magnet, or by 26 smaller electro-magnets. Should the engine work well, I expect to send you a description of it, in time for publication in the October number of the Annals.

Maynooth College, June 14, 1836.

In a paper published in the July number of the Annals, I stated that I was then employed in making an electro-magnetic engine to be worked

by 26 electro-magnets. In the end of June, I tried the engine before it was completed, and found these two defects in it. The first was that some of the magnets were connected by iron where they ought to have been connected by a substance not susceptible of magnetism; the second arose from the number of magnets which were divided into two sets, each containing 13 magnets. I found it impossible in the plan which I adopted, to make an odd number of magnets work, and was therefore obliged to reduce the number of magnets to 24: or to two sets each containing 12 magnets. I also substituted a brass connexion between the magnets for the iron one. I then found that one small electro-magnet was capable of producing circular motion in a wheel which weighed about 100 pounds, and that six magnets were sufficient to give rapid motion to the wheel. The results of the experiments which I made, convinced me that electro-magnetism might be successfully applied to the working of machinery of every kind and I resolved to get made an engine which would do the work of one horse, or perhaps two. This engine will contain 40 electro-magnets, and I expect that, with a battery containing six square feet of zinc, it will propel, at the rate of 7 or 8 miles an hour, a carriage which along with its load, will weigh 13 cwt. The engine will be ready for work in the end of this month or in the beginning of next. By calculations founded on experiment, I have been led to the following conclusions. First, that an electro-magnetic engine as powerful as any of the steam engines on the Kingston Railway, may be constructed for the sum of £250; secondly, that the weight of such engine will not exceed two tons; thirdly, that the annual expense of working and repairing it will not be more than £300. If my calculations be correct, the expense of propelling the railway carriages by electro-magnetism, will be scarcely one fourth of the cost of steam. I have found that the first cost of an electro-magnetic engine, and the expense of working and repairing it, increase only as the square root of the power of the engine. Thus the first cost of an engine of 100 horse power, and the expense of working it will be very little more than ten times the cost of an engine of one horse power. A battery containing 10 square feet of zinc will work an engine 100 times as powerful as that which requires only one square foot of zinc.

N. J. Callan.

Maynooth College, September 11th, 1837.

Annals of Electricity.

Temporary Caissoon for stopping out water while repairing sea-cocks of Steam Vessels.

The following description of a temporary caissoon, applied to H. M. steam-vessel Dee, for the purpose of excluding the water whilst one of the sea-cocks was ground in afresh, by Com. W. Ramsay, R. N., displays that ingenuity under difficulty, for which our seamen are celebrated:—

In describing a caissoon that was used by H. M. steam-vessel Dee, under my command at Port Royal, in the month of August, 1835, the simplicity of the details are such, that it may perhaps be thought by some hardly worthy the attention of the readers of the Nautical; but as all who may have to encountre a similar difficulty may not know how easily

it can be overcome, is a sufficient reason for giving them. It is necessary first to state, for the information of those who are not much acquainted with the fittings of steam-vessels, that there are several sea-cocks, which, when turned, admit the water through the bottom of the vessel for various well-known purposes. The most common plan is to have a pipe, which communicates with the sea. About a foot from the outside of the vessel is the cock, upon which another pipe is fixed which conveys the water to its destination. Now these cocks, by constant use, are liable to leak; when this occurs, the water flows in a stream into the vessel, and the only remedy to be applied is to remove the cock and what is technically called, grind it in afresh, and then replace it. This is, of course, effected without danger when the vessel is in dock, but it is evident, that if attempted when she is afloat, without some method of preventing the water rushing in, if the pipe inside cannot be stopped, which would be very doubtful, the vessel would fill with water.

This being premised, it may be now stated that the sea-cock on the larboard side of H. M. steam-vessel Dee was found to be leaking very much. It was considered that taking off the cock, and trusting to being able to stop the pipe from inside would be dangerous, besides the difficulty, perhaps impossibility, of putting the cock on again when reground, with such a rush of water as it is evident would take place. As there are no locks at Port Royal, the only plan was to stop the aperture (by which means the water enters the vessel) outside, until the necessary repairs were completed.

The vessel was first given as great a heel as possible to starboard, by which the hole to be stopped was brought within four feet of the water's edge; next, having procured several feet of two inch fir plank, a box was made which had three sides, and a bottom, of the following dimensions: the back was five feet deep by four broad, the sides three feet broad, the bottom of course extending from the back to the ends of the sides. The way in which it was rendered water-tight was this: two folds of very thick fearnought boiled in a mixture of tallow and tar was placed between each joining of the planks, and the whole was kept together by the means of iron bolts, which were driven quite through. Now, it was necessary to obtain the exact curve of the vessel's bottom, that the sides of the caissoon might be cut to answer to it. This was effected by means of a long stripe of lead, which was forced during a calm against the vessel's bottom. The curve being thus obtained, the sides and bottom of the caissoon were cut to their proper shapes; small grooves were cut in their edges, and four folds of fearnought, prepared as above, were nailed on. The nails were driven along the grooves, so that when the caissoon came to be pressed against the vessel's bottom, there might be nothing to prevent a good fit. Two large cleets were then nailed upon the vessel's side, on the exact spot that the top of the caissoon would be, so that once forced down into its place, it could not rise again. As near the surface of the water as possible, two strong screw eye-bolts were fixed to the vessel's side, through which lashings were rove, and a tackle got all ready.

The caissoon was now put over, forced down under the cleets mentioned above, the lashings encompassed it, which were hauled tight by the tackle by which means the caissoon was forced against the vessel. A small pump that had been prepared before, was then placed in it, by

the aid of which, and bailing, all the water was got out of the caissoon in about ten minutes, after which one man occasionally bailing kept it quite dry. Having this to work in, the aperture was soon secured, the cock taken off and ground afresh. When that was finished and put in again, the caissoon, which had been allowed to fill with water was pumped out, the lead and plank that had been nailed on to keep the water out of the ship, was taken off, and the whole business was finished without the slightest stop, impediment, or difficulty, in about forty-eight hours. Nautical Mag.

Hot Blast Iron.—British Association.

The *Manufacture of Iron* occupied a very large portion of the time of the section. The first paper on this subject was by Mr. G. Crane, of Ynyscedwyn Iron Works, on the smelting of iron by anthracite coal, of which fully a third of the immense coal field of South Wales, is composed. Mr. Crane had smelted a ton of iron with 27 cwt. of anthracite coal with very satisfactory results as to quality, and found a very considerable saving in using it in preference to bituminous coal. The smelting was now conducted by a cupola furnace, into which a stream of air was urged of heat sufficient to melt lead, this hot blast being all that was requisite to produce the combustion of the coal necessary for the reduction of the ore.

Dr. Thomson gave an account of the result of the experiments carried on at the request of the Association, on the *Comparative Advantages of Hot and Cold Blast Iron.* He had analyzed more than thirty specimens of the Glasgow ore selected with great care, the richest of which had a specific gravity of 3.056, with nearly 85½ per cent. of iron. The roasting of the ore before it was put into the furnace, in order to drive off the carbonic acid, reduced it 85 per cent. Formerly in smelting, ten tons of coal were used for the reduction of one ton of iron. In 1823, when the hot blast was introduced, 2 tons 19 cwt. only were required; 19 cwt. being consumed in heating the air and the boiler of the steam engine. Coals were therefore greatly economised by the hot blast, which produced a concentration of the combustion, and therefore melted the iron in a greater degree. A smaller quantity of lime was required for fusing the clay, and hence a greater quantity of cast iron could be obtained from a furnace in a given time. He had been, from the Carron Iron Works, which were of high reputation, supplied with specimens of No. 1 iron, made from hot and cold furnaces, and found the gravity of the cold blast less than that of the hot blast iron. One specimen of the hot blast iron, No. 2, contained 90½ per cent. of iron. From five specimens of the hot blast from different places, he had obtained a mean of 95½ per cent. of iron. Hot blast was decidedly purer than cold blast full five per cent., and they were of equal strength. The force required to break both sorts was the same, being 2040 lbs., where the iron was ⅜ of an inch thick. A chain of ⅞ths thick, forged from the hot blast iron, had stood the test of 22 tons 7 cwt., twelve tons above the Liverpool chain cable test. The saving in the coal by hot blast was two thirds. No phosphorus had been found in the iron analyzed by him.

Mr. Guest had found a much larger portion of the hot blast lost than of the cold blast in converting it into malleable iron. Mag. Pop. Sci.

Upon the Affinity which the Fluids of living organized Structures have for Water. By M. de Blainville.

Naturalists have long observed how much the hygrometrical and statical condition of the atmosphere; in other words, how much its moisture and weight, exerts an influence over the life of animals, influencing their form, whether small, sleek, and elegant, or on the contrary, heavy, lumpish, and swollen, according as this medium of existence is dry and in brisk movement, or on the reverse, saturated with humidity and stagnant, as is well exemplified by comparing together the inhabitants of Holland and Andalusia. They have also noticed that the habitual use of free potations and watery viands, or on the contrary, very nourishing and dry food, have a manifest effect on the condition of man and animals. As, however, these different results require a longer or shorter time before they take effect, their mode of action, we conceive, cannot be so manifest as it was on the occasion of an observation made in Egypt by M. P. E. Botta, a naturalist connected with the Natural History Museum of Paris, and now travelling in Arabia Felix. His remark is this: Camels, as is well known, are the only means of transport which can be employed in traversing the vast deserts which are encountered in many parts of Africa and Arabia, and this on account of their nature, and still more their habits in which they are reared from their youth, in virtue of which they acquire a power of abstinence to an extraordinary extent, being enabled to refrain from eating, and especially from drinking, during almost an incredible space of time. Here, however, we may remark in passing, that this remarkable power is not to be attributed to the circumstance that these animals are provided with a sort of stomachic reservoir, in which they husband their supply of water, as has been long alleged, and is still repeated in many of our modern publications, but is owing merely to the great extent of the salivary apparatus, which in all animals has a development in the ratio of its common food. Now, during the long journeys across the portion of the great desert which begins or ends at some distance from Cairo, according as you ascend or descend the Nile, M. Botta had occasion to observe that these camels, in proportion as they proceeded from the place of departure, became thin with a rapidity which was very striking and remarkable. He had also occasion to confirm an observation which was made ages ago, that these animals really seemed to smell water at incredible distances, which is inferred from the increased swiftness in the speed of the camels; which, in spite of their enfeebled power, during the progress of a protracted journey, redouble their efforts as they approach the spots where water is found, in hopes of obtaining that refreshing draught which can alone satisfy their thirst and relieve their torments. So soon as these animals reach one of those springs so sparingly scattered over the desert, they throw themselves into it with avidity, and though more or less muddy, they continue drinking it for a long time. That which most of all astonished M. Botta was the almost instantaneous change which this treat produced in them. In fact, after having been in this way reduced to the worst and most meagre condition, after the expiration of a short period of repose, and having drank well, they rise in so much apparent flesh and good condition, that you could scarcely believe them to be the same animals. Since, therefore, there was no other change in their regimen than the introduction into their stomach of a handful of

dry nourishment, and of a great quantity of water with which they had just before gorged themselves, it is clear that this alteration in their condition, so sudden and so apparent, can be attributed only to the introduction of the watery fluid first into their stomach, then into the circulating fluids, and, finally, into the cellular tissue, in consequence of a true act of imbibation through the continuity of substance, whether circular or capillary, as in a sponge, and perhaps also by that process which is now denominated *endosmose;* that is to say, by the affinity which the liquids of a living organized part have for moisture, after they have been deprived of it by great exhalation. Ed. New Phil. Jour.

Miners' Patent Safety Fuse.

In our present number will be found a brief report of an application made to restrain a party from manufacturing the "Miners' Patent Safety Fuse," which article we have had frequent occasion to notice as being one of the most important and useful inventions connected with mining.

We shall endeavor briefly to describe its properties, and thus enable those who have embarked in mining pursuits to judge of the value to be attached to the use of the "fuse," while its safety is in itself one of its strongest recommendations.

The "Patent Safety Fuse" is devised for safety and certainty in conveying fire to the charge in blasting rocks and in mining. It is in appearance like a firm varnished cord, just the size of a large goose quill, and has in its centre a continuous column of the best gunpowder—for convenient carrying and packing, it is manufactured in lengths, of twenty-four feet, coiled up like rope, the smallest coils being about three, and the largest about fifteen inches in external diameter, so that the different sized coils fall into each other and pack closely into small kegs or casks. It is so hard and firm in its texture, as to resist the action of tamping, is impervious to water, can be easily cut with a knife to any length, burns regularly in a measured time, conveying the fire at the rate of half a minute to the foot, and will act as certainly in a close rock firmly tamped up under twenty fathoms of water as on dry ground and in the open atmosphere.

The great advantages resulting from the use of this instrument have been acknowledged wherever it has been used. It offers protection to the workmen engaged in this hazardous employment; in large mining districts, where mutilation and death were frequent from premature explosions, accidents now very seldom occur. Its use occasions no trouble, but in comparison with every other mode greatly facilitates the operation. It is not only cheaper and more effectual than every other thing used for the purpose of certainly and slowly conveying fire to the charge, but is absolutely cheaper than blasting with the needle and straw, by saving a great portion of the powder necessary for the charge.

The Safety Fuse has consequently been long used in all the Cornish mines; has been strongly recommended by John Taylor, Esq., F. R. S., &c., Colonel Burgoyne, chairman of the Board of Public Works in Ireland, Mr. Purdy, secretary of the Mining Association of Ireland, and many distinguished scientific and practical gentlemen, connected with mining operations.

We can with justice add our testimony to its value, and do not hesi-

tate to recommend its general adoption. We have before observed, that specimens of it may be seen at our office, or will with pleasure be transmitted to parties interested. Mining Journal.

On a New Rain Gauge.—By the Rev. THOMAS KNOX.

On the 26th of June last, a new rain gauge was exhibited to the Royal Irish Academy, contrived by the Rev. Thomas Knox.

The object of this instrument is to register the amount of rain that falls when the wind is in different points. Its construction is very simple. The water—instead of descending from the reservoir directly into the tube of registry—passes through a lateral tube into an annular-shaped vessel, divided into eight compartments, each of which terminates below in a graduated glass tube. It is obvious, then, that if the eight tubes be set to correspond with the cardinal and intermediate points, and that the reservoir be made to revolve on a vertical axis by means of a vane, the direction of which corresponds with that of the lateral tube, the object proposed will be attained. Mr. Knox has preferred to make the reservoir fixed, and the system of tubes movable; but the result is obviously the same. Lon. & Ed. Philos. Mag.

On an Easy Method of preparing Platina Black.—By M. DÖBOREINER. *Translated for this Journal, by* JOHN GRISCOM.

Melt platina ore (crude platina) with double its weight of zinc, and treat the alloy thus obtained and reduced to powder,—first, by dilute sulphuric acid, and then by dilute nitric acid, in order to oxidate all the zinc. This, contrary to theory, is but slowly effected, even at a high temperature. A dark grey insoluble powder of native platina remains, mingled with osmiuret of iridium. This powder acts like platina black, after it has been properly purified by lixivium of potash, and it has such an oxidizing action that it transforms not only formic acid into carbonic, and alcohol into acetic acid, but even the osmium which it contains absorbs oxygen from the air, and is disengaged by degrees in the state of osmic acid.

This method of preparing platina in an extremely divided state, was recommended by Descotils thirty years ago, and he was the first to observe that the powder thus obtained detonates by heat like gunpowder, and that muriatic acid destroys this property.

When platina powder prepared by zinc is moistened with alcohol, it becomes incandescent and osmic acid is disengaged; but if it be mixed with alcohol so as to form a paste, and spread out on a watch glass, it disengages only acetic acid. This is the most simple process of purifying the air of a chamber. Jour. des Mines.

A process of purification rather too troublesome and expensive when ventilation and lime can be easily resorted to. It may, perhaps, be eligible in a sick room. TR.

Progress of Physical Science.

Method of producing a Permanent Soap Bubble, illustrating the colours of Thin Plates. By Dr. J. Reade.

The first account of the colours produced by thin plates is to be found in Mr. Boyle's works: "To show the chemist that colours may be made to appear or vanish, where there is no accession or change either of the sulphureous, the saline, or the mercurial principles of bodies, he says that all chemical essential oils, as also good spirits of wine, by shaking till they rise in bubbles, appear of various colours, which immediately vanish when the bubbles burst, so that a colourless liquor may be immediately made to exhibit a variety of colours and lose them in a moment without any change in its essential principles: he then mentions the colours that appear in soap bubbles, and also in turpentine. He sometimes got glass blown so *thin* as to exhibit similar colours." Here we may remark, that although Mr. Boyle did not advance any theory from these experiments, yet it is evident that he connected the production of colours with the thinness of the substance, as appears from his endeavours to blow glass sufficiently thin. This suggestion in all probability afterwards gave the idea to Dr. Hooke, and finally to Sir Isaac Newton, who has the merit of clothing Hook's suggestion in a mathematical dress, beautiful and interesting in the extreme.

Dr. Hook was the next to investigate this subject; at a meeting of the Royal Society, 7th March, 1672, he promised to exhibit at their next meeting something which had neither reflection nor refraction, and yet was diaphanous; he then produced a bubble of soap and water. It was no wonder that so curious an experiment should excite the interest of one of the most learned, liberal and scientific societies in Europe; they requested him to bring an account of it in writing at their next meeting. "By means of a glass pipe he blew several small bubbles out of a mixture of soap and water, when it was observable that at first they appeared white and clear, but that after some time the film growing thinner, there appeared upon it all the colours of the rainbow, first a pale yellow, then orange, red, purple, blue, green, with the same series of colours repeated." Sir Isaac Newton's experiments as exhibited in his Optics are so well known, that I shall not enumerate them in this paper, merely remarking that his bubble was so evanescent that it burst before he had time to make an accurate examination. Melville of Edinburgh thought to make a permanent soap film by means of freezing. This was impossible. It occurred to me that by taking off the atmospheric pressure, I might accomplish my purpose; I therefore made the following experiment.

Exp.—Having put two ounces of distilled water into an eight ounce phial, and having added about the size of a large pea of Castile soap, I placed the bottle in a saucepan of boiling water on the fire; the bottle was speedily filled with a dense volume of vapour, which expelled all the air. I now corked it, and after cooling, and thus condensing the vapour, had perhaps as perfect a vacuum as could be formed, even by the best air pump.* I now held the bottle laterally between my hands, and by means of a circular and brisk motion formed a circular film, on which

*This vacuum, we apprehend, may be vitiated by the entrance of atmospheric air through the cork, indicating the necessity of covering it with cement.—Edit. Mag.

by resting the bottle on an inclined plane, were formed after a short time all the parallel bands or series of colours in the following order: 1. a white or silvery segment at top; 2. a snuff-coloured brown inclining at bottom to a deep red; 3. blue; 4. yellow; 5. red; 6. blue; 7. green; 8. red: 9. green; 10. red; 11. green. (See Figures below.)

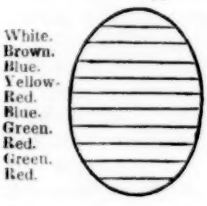
After some time a black segment was seen to form at the top of the white and continually to increase in size. After a few minutes the parallel bands increased in breadth, and running into one another only three or four distinct bands were seen. Nothing can exceed the beauty of these colours, equal to those of the rainbow, or the plumage of the tropics: whilst writing this description I have these bands in a bottle before me, feasting my eyes on their beauty. In a few minutes more this black segment of aqueous film occupies, perhaps, half the circular film, and the lower half becomes white tinged with orange.

If we now incline the bottle towards the experimenter's breast, the saponaceous atoms producing these colours are seen to float in the region of the black or aqueous: when placed again on the inclined plane they fall to the bottom of the films. In some time more the entire film becomes black, and all the colours disappear.

Having now placed the bottle in a basin of boiling water the evaporation was increased, and the black film soon became clothed with saponaceous atoms, which being variously condensed produced all the colours of the clouds when the sun is setting on a summer's evening. On again placing the bottle on the inclined plane the parallel bands were again formed by the attraction of cohesion, and the colours afterwards gave place to the black film. I held the bottle laterally between my hands, and by means of a circular motion washed it, and thus clothed it with saponaceous atoms, which went through the same process on placing the bottle on the inclined plane. By means of washing the film every morning, I preserved it for more than three weeks. This simple experiment opens a wide field of investigation to the natural philosopher, and enables him at his leisure to examine the interesting phenomena of these colours.

London, Sept. 4, 1837.

1.



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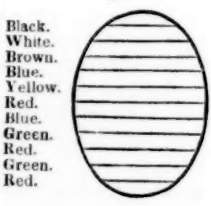

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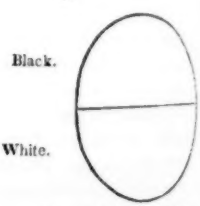

Lon. & Ed. Phil. Mag.

On the luminous properties of Chloride of Calcium, by CHARLES TOMLINSON, ESQ.

When chloride of lime is subjected to a red heat in a Hessian crucible, it undergoes the watery fusion and is gradually decomposed. Chlorine is at first evolved, then oxygen; and chloride of calcium remains in the crucible. This substance, when thus treated, emits a pale green phosphorescent light, visible in the dark, and was formerly called on

this account, *Phosphorus of Homberg*, this chemist being the first to record the fact.

But when the chloride of lime is completely melted in its water of crystallization, if the crucible be removed to a darkened room and allowed to cool gradually, not only does the phosphorescent light remain for many minutes, but large and distinct electric sparks and corruscations are visible, accompanied by a crackling noise due probably to the sudden contraction of the mass, or to its crystallization.

These phenomena can also be seen in the dark by dipping a glass rod into the fluid, a large portion of which concretes around it, and can be withdrawn with the rod.

When the contents of the crucible have cooled down, and all phosphorescence has disappeared, the sparks can be obtained most admirably by striking the cloride with a sharp instrument of any material; by simply scratching it; or by snapping a piece asunder; or by percussion with a hammer; and both sparks and phosphorescence can be obtained by grinding the substance in a mortar, and the luminous effects remain for a few seconds after the grinding is discontinued.

The colour and intensity of the sparks thus produced seem to vary with the degree of mechanical force employed; thus, a gentle scratch produces green sparks; a firm scratch, yellow green; a blow with a sharp instrument, yellow; snapping a piece asunder also affords a yellow spark, and a smart blow with a hammer affords a spark of an orange colour.

All these effects are best seen with the newly fused chloride; it absorbs water by exposure to the air and its electrical properties gradually decline; I have, however, obtained the sparks from it after a few day's exposure, but they were wanting in the brilliancy which characterize those obtained from the substance when newly fused.

The term *phosphorescence* seems to be a very bad one and calculated to mislead; since it is highly probable that all recorded instances of phosphorescent minerals, &c. (except, of course, phosphorus itself and its compounds) are due to electricity. It has been shown by Dessaignes that metallic bodies are capable of electric excitation by the simple processes of heating and cooling. Morgan has shown that there is no fluid nor solid but may be rendered luminous by the transmission of an electrical discharge through its substance; and that the difficulty of producing this appearance in all bodies increases as the conducting power of the body decreases. Skrimshire has given a long list of minerals, in which calcarious bodies occupy a conspicuous part, which become phosphorescent by the electrical discharge; and Brewster also has a long list of mineral substances which become phosphorescent by heat. Now the appearance of the hot chloride of calcium is similar to that of white sugar, immediately after an electrical discharge has been transmitted through it. All calcarious substances present this appearance in a high degree when similarly treated, and the exciting cause is probably the same; for whether we employ the electrical battery or the hot crucible, heat is communicated to the substance, and heat is favourable to electrical excitation. A piece of lump sugar, mica, &c. when suddenly snapped asunder, and cotton cloth when suddenly torn, show the electric spark; so also does the fracture of the chloride of calcium. An enquiry, therefore, seems to be wanting into the connexion between

phosphoresence and electricity since it is manifest that the appearances attending the slow combustion of phosphorus, and the light emitted by certain minerals when heated, &c. though similar in appearance are due to very different causes.

Salisbury, March 4, 1837. Annals of Electricity.

Atmospherical Phenomena.

M. de le Rive read a second paper "On an Optical Phænomenon observed at Mount Blanc." When the sun has set at Geneva, it is observed that Mount Blanc remains illuminated by its direct rays for a much longer time, than the surrounding mountains. This phænomenon is owing to the great height of Mount Blanc. But after it had ceased to be illuminated, the summit of Mount Blanc sometimes appears at the end of ten or fifteen minutes, less intensely enlightened than at first, but nevertheless in a manner very decided, and often very brilliant. This phænomenon takes place especially when the atmosphere is very pure—highly charged with aqueous vapour in an invisible state—and, consequently, very transparent. The author has satisfied himself (by the exact observation of the time which elapses between the two successive illuminations of the mountain, combined with the calculation of the sun's progress) that the phenomenon is due to the rays of the sun which traverse the atmosphere at a distance from the earth less than the height of Mount Blanc, but greater than half that height, and which arrive at rarer regions of the atmosphere under an incidence so great that they are reflected instead of refracted. This interior reflection is facilitated by the humidity of that part of the atmosphere which the rays traverse until they reach the point of incidence. The reflected rays falling on the snowy summit of Mount Blanc, produce this second illumination; and the humidity (by augmenting the transparency of the air) renders the illumination more brilliant.

Sir D. Brewster stated, that he had witnessed a similar effect, though on a less magnificent scale, on the Grampian Hills; but he had always observed, that on such occasions the sun set in a red west, and that all the clouds in that quarter of the heavens were then red.—M. de la Rive replied, that the phænomenon he spoke of only appeared when the sky was quite free from clouds, and, in truth, it was most brilliant when the air was very transparent in consequence of its being loaded with vapour in its elastic state.—Professor Lloyd said, that the distinctness and vividnes with which distant objects were seen in some states of the atmosphere, was quite astonishing; on one occasion, he had seen from the neighbourhood of Dublin the Welsh hills from their very bases, and brought so near, apparently, that he could absolutely see the larger inequalities of the surface upon the sides of the mountains. That the atmosphere was at that time very much loaded with vapour in a highly transparent state, was obvious from the fact, that immediately after, a very heavy fall of rain took place, and continued for a considerable time. Professor Stevelly wished to confirm what had fallen from Professor Lloyd and M. de la Rive, by stating that whenever the Scottish hills appeared with that peculiar vividness and distinctness from the Lough of Belfast, the fishermen always looked upon it as a sure precursor of heavy rain and wind. A friend had informed him, that on one occasion he

had noticed this appearance while standing on the beach at Hollywood, and pointed it out to an old fisherman; the old man immediately gave notice to all his friends to whom he had access, who instantly set about drawing up their boats and placing their small craft in more secure places; early the next morning a violent storm came on, which did much damage on the coast, to those who had not been similarly forewarned. Thus we find that the most interesting pursuits of the man of science, and the most important concerns of man in the practical details of life, frequently approach, and each may lend important aid to the other.—Mr. Lubbock was of opinion that the principal fact mentioned by M. de la Rive would receive a simple solution, if we admit the theory of Poisson regarding the constitution of the atmosphere. That eminent mathematician conceived that analysis led irresistibly to the conclusion that the upper portions of the atmosphere were, by the extreme cold there existing, condensed into a liquid, or even into a solid: if this were so, we could easily conceive how the reflection of the light from its under surface would re-illuminate the top of Mount Blanc after the direct light of the sun had ceased to reach it.—Sir David Brewster expressed much surprise at hearing, for the first time, of this theory of Poisson, and that he should feel much obliged to Mr. Lubbock if he would give some details of it in a separate communication to the Section; and he had little doubt but that it would be as new and acceptable to many gentlemen as to himself. He thought that the near apparent approach of distant objects in certain states of the air, as mentioned by Professor Lloyd and Professor Stevelly, might perhaps be accounted for by supposing that on these occasions the intervening air became actually converted into a large magnifying lens. Brit. Ass. for Adv. of Sci.—Mechan. Mag.

British Association.—Corrosion of Iron by Salt Water.—Singular action of Nitric Acid on Metals.

Mr. Hartley read a paper "On the corroding of Iron by Salt Water." The object of the paper was to shew that brass protects both bar and cast iron in a very perfect manner. The brass did not appear to have undergone any action, which, as stated by the President, Dr. Faraday, is rather opposed to received notions of electro chemical action.

Dr. Andrews next read a paper, "On some Singular Modifications of the Ordinary Action of Nitric Acid on certain metals." Bismuth in nitric acid of specific gravity 1.4, was rapidly acted upon, but this action immediately ceased when the bar was touched by platinum. On removing the platinum from the liquor, the bismuth will sometimes begin again to dissolve; at other times, its surface will become covered with a black crust, which is soon removed by the acid; but the metal, though now exhibiting a beautifully polished surface, is no longer acted upon by the acid, or, at least, is dissolved only with extreme slowness. Thus, a slip of metal, which in its ordinary state will require only a few seconds to complete its solution, will, when thus slightly modified, resist, for many hours, the action of the same acid.

Copper and tin present similar phænomena, but zinc, when treated in the same way, has its oxidation and solution not arrested, but merely retarded. Arsenic was found to present a singular anomaly when heated in nitric acid, so as to give rise to effervescence: the contact of plati-

num in the usual way did not produce any effect, whereas, when an acidulous solution of silver is used, platinum exercised its usual influence.

In the case of six metals, platinum checks the action of nitric acid, and three of them appear to be brought into a permanently peculiar state opposed to chemical action. Platinum always separates any film of oxide as its initial function, but after its separation, it exercises a polarizing action; for example, it brings the other metal into a peculiar state, which enables it to resist chemical action.

On the conclusion of this paper, the President drew the attention of the Section to the analogy between the facts detailed by Dr. Andrews, and the preservation of iron by brass, as instanced in the communication of Mr. Hartley. In both cases, according to the known laws of electro-chemical action, effects, the very opposite of what are observed, should present themselves. The bismuth, copper, &c., should oxidize quickest when in contact with the platinum; and if, as would seem demonstrated by Mr. Hartley, brass protects wrought and cast iron, the brass itself should be acted upon with increased rapidity. The solution of these anomalies, he conceived quite within the range of science in its present state, and he urged upon the members of the section the necessity of studying the phenomena in question, as their explication would constitute a very valuable addition to the existing state of our electrical knowledge. Mec. Mag.

Mechanics' Register.

Origin of Amber. By H. R. Goppert.

This substance was found at Muskaur, in large quantity in fossil wood, belonging evidently to the genus Abus, and in other specimens very nearly allies to the genus Larix. They are all found in the brown coal formation. Amber likewise occurs in coniferous plants, associated with ferns in the coal of Wening-Rackvitz. Since, then, it appears that we already know four different species of tree which afford amber, (and the number would doubtless be increased by attentive investigation,) the probability seems to me to be rendered still stronger, *that amber is nothing else than an indurated resin derived from various trees of the family of the Coniferæ; which resin is found in a like condition in all zones, because its usual original depositories, viz. beds of brown coal, have been formed almost every where under similar circumstances.*

Edin. New Philos. Jour.

Sir Isaac Newton's Manuscripts.

An erroneous statement having found its way into the newspapers, respecting the purchase of Sir Isaac Newton's MSS. by the Royal Society, we are authorized to state that it has no foundation whatever. In consequence of Sir David Brewster being at present engaged in a large work on the life, writings, and discoveries of Sir Isaac Newton, he was kindly permitted by the trustees of the Earl of Portsmouth to examine the valuable collection of MSS. at Hursbourne Park. With the assistance of H. A. W. Fellowes, Esq., the accomplished nephew of Lord Portsmouth, many interesting and important letters and papers

were discovered, which not only throw much new light on the early life and studies of our immortal countryman, but tend to refute the groundless rumours respecting a temporary derangement of his mind in 1692, and to exalt, in the highest degree, his moral and intellectual character.—*Morn. Chron. June 27.*

Lon. & Ed. Philos. Mag.

New Waggon Steam Drag.

Mr. Boydell, of Dee Cottage, near Chester, has invented a locomotive engine, which, when fixed to heavy waggons, &c., will propel them on common roads at a very rapid rate. It was exhibited on Tuesday, and elicited the strongest approbation from many scientific and practical men who witnessed the trial, and minutely examined the machinery. It is applicable to ploughs, which it propels with great ease and velocity.

Chester Courant.—Mec. Mag.

Paris and Brussels Railway.

The railway which has long been projected for uniting the capitals of France and Belgium, at length bids fair to be commenced in good earnest. The king of the French has just granted to Mr. John Cockerell, the celebrated English iron master of Leige, the "concession" of the railway for fifty years. The French government is to advance 25 per cent. of the cost, on the distance from Paris to the Belgian frontier; and Mr. Cockerill is to be entitled to all tolls and profits for the first half century, when, it is to be presumed, the works will become the property of the nation. The only condition with which the grant is accompanied, is, that the toll for the French portion of the railroad shall never exceed *fifteen* francs, or 12*s.* 6*d.* The terms of concession were not agreed to until after the "high contracting parties," Louis Philippe on one side, and Mr. Cockerill on the other, had had several personal interviews. The latter must be allowed to possess a most adventurous spirit; he was a severe sufferer by the revolution at Brussels in 1830; and yet, it seems, is not deterred from adventuring his capital on a soil like that of France, which in fifty years may experience, probably, half as many revolutions.

Mec. Mag.

The Thermo-electric Spark, obtained from a single pair of Metallic Elements.

By Mr. Francis Watkins.

With a pair of metallic elements, consisting of one bismuth and one antimony, weighing each five grains, and measuring 0.5 of an inch long, and 0.12 diameter, when their extremities were unequally heated, I have obtained, with a Henry's flat ribbon coil, a very perceptible and brilliant spark.

Now I have pen in hand, permit me to state that with thermo-piles I actuate most of the apparatus usually employed for illustrating electro-magnetic phænomena, so that the public teacher may now show by the same apparatus the several rotations, &c., with thermo-electricity, as he does with voltaic electricity.

Lon. & Ed. Philos. Mag.

Celestial Phenomena for March 1838.

LUNAR OCCULTATIONS FOR PHILADELPHIA, JANUARY 1838.					Angles reckoned to the right or westward round the circle, as seen in an inverting telescope. ☞ For direct vision add 180° ☜	
Day.	H'r.	Min.	Star's name.	Mag.	from Moon's North point.	from Moon's Vertex.
4	10	0	Im. of *c* Aurigæ	,6,	64°	125°
4	11	16	Em. ‘		272	333

Meteorological Observations for October, 1837.

Moon.	Days.	Therm. Sun rise.	Therm. 2 P.M.	Barometer Sun rise.	Barometer 2 P.M	Wind. Direction.	Wind. Force.	Water fallen in rain.	State of the weather, and Remarks.
				Inches	Inches			Inches.	
	1	60°	69°	29.80	29.84	W.	Moderate.		Clear—do.
	2	54	71	29.95	29.90	W.	do.		Clear—lightly cloudy.
	3	55	64	29.96	30.0	W.	do.		Partially cloudy—do. do.
	4	46	54	30.10	30.15	W.	do.		Cloudy—clear.
	5	36	57	30.20	30.00	S.	Brisk.	.7	Clear—frost—cloudy—rain.
	6	52	56	29.80	29.80	N.	do.	.24	Partially cloudy—rain.
☾	7	40	58	29.95	29.97	W.	Moderate.		Clear—partially cloudy.
	8	45	54	29.97	30.10	NE.	Brisk.		Partially cloudy—do. do.
	9	36	51	30.35	30.40	NE.	do.		Partially cloudy—cloudy.
	10	46	64	30.26	30.14	NE.	Moderate.		Cloudy—do.
	11	51	70	30. 5	30. 5	W.	do.		Clear—do.
	12	55	72	30. 5	29.90	W.	Brisk.		Partially cloudy.—do.
	13	42	44	29.80	30. 5	NE.NW.	do.	.16	Rain—do.
☉	14	30	60	30.25	30.20	NW.	do.		Clear—do.
	15	36	59	30.20	30.20	W.	Moderate.		Clear—do.
	16	50	62	30.10	30.15	W.NW.	do.		Partially cloudy—do. do.
	17	45	64	30.35	30.22	W.	Calm.		Clear—cloudy.
	18	54	56	30.00	30.00	SW.	do.		Cloudy—clear.
	19	57	70	29.80	29.90	W.E.	Moderate.		Clear—do.
	20	55	66	29.85	29.70	SE.	Brisk.	.2	Cloudy—rain.
☽	21	48	58	29.86	29.95	W.	do		Cloudy—do.
	22	44	63	30. 5	30. 5	NE.SW.	Moderate.		Partially cloudy—clear.
	23	50	75	29.95	29.90	W.S.	do.		Clear—do
	24	55	76	29.90	29.85	W.	do.		Fog—clear.
	25	60	67	29.85	29.85	SE.	do.		Fog—cloudy.
	26	56	59	29.84	29.83	E.	Brisk.		Cloudy—do.
	27	45	49	29.84	29.86	NE.NW.	do.		Rain—cloudy.
	28	36	50	29.95	29.95	W.	do		Clear—cloudy.
⊗	29	32	42	30.00	30.00	NW.	Blustering.		Coudy—clear
	30	29	47	29.83	29.90	NW.	Brisk		Cloudy—cloudy.
	31	36	15	30.00	30.00	NE.	Modrate.		Clear—do.
	Mean	46.45	59.93	29.99	29.99			.49	

		Thermometer.	Barometer.
Maximum	height during the month	76.00 on 24th.	30.40 on 9th
Minimum	do.	29.00 on 30th.	29.70 on 20th
Mean	do.	53.19	29.99